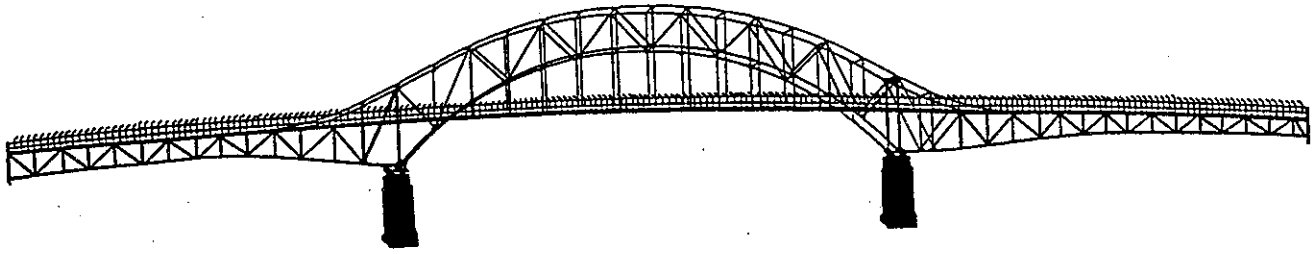
US Army Corps
of Engineers
New England Division



Bourne Bridge
Cape Cod Canal
Bourne, MA

October 1992

New England Division

INSPECTION REPORT

BOURNE HIGHWAY BRIDGE

CAPE COD CANAL

BOURNE, MA

U.S. ARMY CORPS OF ENGINEERS

BOURNE HIGHWAY BRIDGE

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BOURNE HIGHWAY BRIDGE

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I. INTRODUCTION

The Bourne Highway Bridge which crosses the Cape Cod Canal approximately two miles from its western end provides one of only two access points between Cape Cod and the mainland (See Figure 1). The bridge carries four ten foot wide traffic lanes plus a pedestrian sidewalk, and provides a minimum vertical clearance of 135 feet over a horizontal distance of 480 feet for shipping through the Canal.

The bridge consists of seven spans; a three span continuous truss main span, and four approach spans. Simple truss approach spans of 240 feet and 270 feet on the south side, and 240 feet and 208 feet on the north side, flank the 1408 foot main span. The main span consists of a 616 foot center span with side spans of 396 feet each. The trusses of the center 880 feet are arched, reaching a maximum height of 120 feet above the roadway at the center panel point. The roadway deck of the center 440 feet is suspended from lower truss panel points by double wire rope hangars at the ends of each floorbeam. All other floorbeams frame directly into the trusses. The substructure consists of two channel piers, four intermediate piers, and two abutments, all of reinforced concrete. Total length between centerline of abutment bearings is 2384 feet. Each abutment provides a concrete framed bridge deck, 150 feet long, for a total structure length of 2684 feet (See Figure 2).

II. INSPECTION PROCEDURE

A. Physical Inspection

The physical inspection of the Bourne Highway Bridge was performed with two teams of inspectors, using two different methods of accessing particular areas of the bridge. All team members were Corps of Engineer personnel familiar with the overall bridge geometry. One team, consisting of two Corps of Engineer inspectors and a contracted equipment operator, worked from a 150 foot truck mounted aerial platform to access areas over land or above the bridge deck. This eliminated the need to rig the majority of the bridge. The second team, also consisting of two Corps of Engineer inspectors, inspected the underside of the suspended portion of the main span which was above the Canal.

The aerial platform and rigging of safety cable along the wind chords on the east and west sides of the bridge were procured by contract with Marr Scaffolding Co., Boston, MA. Inspection of the underside of the suspended portion of the main span was accomplished by rigging safety cables along both sides of the bridge approximately four feet above the level of the wind chords. The inspectors accessed the wind chords from the sidewalk through access panels in the suicide fence. In this manner, safety lines could be secured to the rigged cable prior

Truck-mounted aerial platform (Condor 150) in various locations, accessing underside of Bourne Bridge.

to actual traversing of wind chords. The physical inspection was then performed from the wind chords, cross bracing and catwalk.

Inspection of the remaining portions of the bridge was performed from the aerial platform. Spans 2 through 7 were accessed from the bridge, while the arch portion of Span 1 was accessed from the deck surface. During the inspection of the arch portion of Span 1, traffic control limiting vehicular flow to one lane in each direction on the curb (east) side of the bridge was required. All aspects of traffic control were capably and safely provided by personnel from the Cape Cod Canal Office.

Sequence of inspection proceeded from the south side of the bridge working from Pier 1 southward completing Spans 3, 5 and 7; then proceeded to the north side of the bridge working from Pier 2 northward completing Spans 2, 4 and 6; concurrently the second inspection team completed the underside of Span 1 working from south to north; the final area inspected was the arch portion of Span 1 from the deck surface (this was performed after Labor Day to minimize any impact on traffic.)

New England Division personnel directly engaged in the field inspection and subsequent preparation of this report include the following:

Joseph A. Colucci, P.E.	NEDED
Francis C.K. Fung, P.E.	NEDED
Francis K. Keefe	NEDCD
Michael E. Walsh, P.E.	NEDED

B. Documentation

The inspection was set up such that every structural steel member (main and secondary), bearing, connection, hangar cable, pier, abutment, etc., was visually inspected to ensure that any area of deterioration or possible area of concern of any type was properly noted. All pertinent data was recorded in field logs and on microcassette recorders.

Numerous photographs were taken showing both the general condition of the various members and parts of the structure, and details of any deteriorated areas of note. A complete set of photographs (including negatives), as well as all field logs and microcasettes completed during the inspection, are on file in the General Engineering Branch, Design Division, Engineering Directorate; New England Division, Waltham, MA. The most appropriate of these photographs were selected and included as Appendix A of this report. To provide continuity between report text and Appendix A photographs, the Appendix has been divided into the following sections:

Section	Pages	Description
1	A-1 - A-3	Substructures, Concrete
2	A-4 - A-7	Bearings
3	A-8 - A-11	Main Members
4A	A-12 - A-15	Lateral Bracing and Connections, Span 1
4B	A-16 - A-20	Lateral Bracing and Connections, Spans 2-7
5	A-20 - A-23	Cable Hangars, Misc. Steel Underdeck, Span 1
6A	A-24 - A- 26	Steel Members Below Joints at Panel Pond 10'
6B	A-27 - A-29	Steel Members Below Other Joints
7	A-30	Scuppers
8	A-31	Sidewalk Framing
9	A-32	Sidewalk/Curb Exterior, Suicide Fence
10	A-33	Catwalk, Underside of Deck
11	A-34	Miscellaneous

III. PURPOSE

The primary objective of this inspection is to maintain conformance to the National Bridge Inspection Standards of the Federal Highway Administration. However, the criticality of this structure to both the Corps of Engineers and the general public, as well as any legal obligations, dictates a systematic and thorough inspection which satisfies the following objectives:

1. Locate and determine the extent of any structural deficiency, whether critical or minor, resulting from normal deterioration or any other cause.

2. Develop a chronological record of the conditions of the bridge, providing a basis for analyzing the significance of any structural changes.

3. Provide an effective and efficient maintenance program by early detection of structural deficiencies including prompt identification of areas or members which may require more detailed future inspection and/or testing procedures.

4. Maximize public safety by the elimination or correction of all hazardous or potentially hazardous conditions.

IV. INSPECTION ITEMS

The following items were visually inspected:

A. SUBSTRUCTURE

1. Abutments
2. Main Channel Piers
3. Intermediate Piers

B. SUPERSTRUCTURE

1. Truss Bearings
2. Main Truss Members & Connections
3. Truss Bracing Members & Connections
4. Cable Hangars (Span 1 only)
5. Floor Beams and Stringers
6. Suspended Floor Bracing(Span 1 only)
7. Sidewalk and Curb Supports
8. Deck
9. Expansion Joints
10. Bituminous Wearing Surface & Waterproofing Membrane
11. Paint
12. Miscellaneous
    a. Catwalks
    b. Light Standards
    c. Suicide Fence
    d. Access Ladders
    e. Scuppers
    f. Sidewalk/Curb

V. EXISTING CONDITIONS

A. RECENT MAINTENANCE

A major rehabilitation was performed on the Bourne Bridge during 1979 and 1980. Work performed included replacement of the bridge deck with a steel grid system, with lightweight concrete infill; new waterproofing membrane and bituminous concrete wearing surface; strengthening of upper and lower lateral bracing on the approach spans; repairing over 250 members; repairing or replacing over 200 gusset or stay plates; replacing approximately 3000 lacing bars; replacing approximately 3000 deteriorated rivets with high strength bolts; installation of new roadway joints; and painting the steel superstructure.

B. SUBSTRUCTURE

1. Abutments.

Both the North and South Abutments were found to be in good condition. In 1969 and again in 1986, all piers and abutments were patched in areas of spall deterioration and epoxy injected in areas of significant cracks. In general, these repairs appear to be in good condition, although deterioration of patches at the top edges of bearing seats on both abutments were observed. See Photo B27-4, Page A-1. In 1988, the top 1 1/2 inches of the abutment (the tops of which serve as the roadway deck) was replaced with an equivalent depth microsilica concrete overlay. The overlay was covered with a new waterproofing membrane and a 1 1/2 inch bituminous concrete wearing surface. This repair also appears to be in good condition. Areas of isolated deterioration were noted on sections of brestwalls, wingwalls and parapets. The parapets, in particular, showed several areas of apparent unsound concrete.

2. Piers.

a. Channel Piers.

Piers 1 and 2 are gravity structures consisting of hollow shafts tied by a hollow cap beam and supported on a concrete monolith twenty-five feet thick. A granite-faced pedestal, 14-foot high sits on the supporting monolith. The shafts above the granite-faced pedestal are reinforced with structural steel frames.

The overall condition of Piers 1 and 2 is very good. As mentioned previously, spalls and cracks were patched or epoxy injected in 1969 and again in 1986, and these repairs appear to be in good condition. The granite stone facing at the waterline consists of 2 foot high stone of varying lengths and depths. The general condition of the granite stone and mortar joints appears to be very good with isolated areas of minor mortar loss from joints. The overall good condition of Piers 1 and 2 is shown in Photos B37-1 and B35-19, pages A-2 and A-3, respectively.

b. Intermediate Piers.

Piers 3, 4, 5 and 6 are gravity structures consisting of two shafts tied by a cap beam and supported on a concrete monolith of varying length. The four piers are generally in good condition. Similar to the main channel piers, the intermediate piers were repaired in 1969 and 1986 by patching and epoxy injection. These repairs appear to be only in fair condition. Deteriorating patches along the top edges of Piers 3, 4 and 6, and general surface staining and minor surface abrasion, primarily on the tops of all intermediate piers were observed. The condition of substructure elements are shown in Appendix A, pages A-1 to A-3.

C. SUPERSTRUCTURE

1. Truss Bearings.

The truss bearings are configured from south to north, with corresponding Appendix A locations as indicated below:

Location	Type	Appendix A
South Abutment	Fixed	A-4
Pier 5 South	Expansion	A-4
Pier 5 North	Fixed	A-4
Pier 3 South	Expansion	A-5
Pier 3 North	Expansion	A-5
Pier 1	Fixed	A-5
Pier 2	Expansion	A-7
Pier 4 South	Expansion	A-6
Pier 4 North	Expansion	A-6
Pier 6 South	Fixed	A-7
Pier 6 North	Expansion	A-7
North Abutment	Fixed	A-7

All truss bearings were found to be in good condition and appear to be functioning properly. Previously reported bent anchor bolts at bearings on Piers 3, 4 and 5 were repaired in 1979. The condition of truss bearings are shown in Appendix A, pages as noted above.

2. Main Truss Members and Connections.

The primary structural support for the roadway is provided by two lines of trusses, one at each side of the deck. Main truss members consist of built-up shapes, plates and lacing bars.

The main truss members and connections in all spans were found to be in good condition. All rivets, stay plates and stiffener plates previously reported to have significant deterioration have all been replaced in 1979 as indicated above. Most members, however, show some degree of rusting varying from minor to occasionally moderate. The interiors of upper and lower chords, which present particularly difficult access problems, show extensive peeling of existing paint. See Photos BC3-16 and BC7-15, page A-8, and B8-1 and B20-8, page A-9. The underside of laces on the top of lower chords and diagonals, and stiffener plates on the interior of connections, other areas of difficult access, also show accelerated rates of rusting and peeling. See Photos B5-18, B11-5, and B21-13, page A-9; and B20-8, page A-10. The condition of main truss members and connections are shown in Appendix A, pages A-8 to A-11.

3. Truss Bracing Members and Connections.

The bracing for the trusses consists of the upper lateral, lower lateral, and vertical sway bracing systems.The previous condition report stated that the upper and lower lateral bracing systems were in the worst condition of any of the structure elements. As indicated previously, extensive rehabilitation was performed on the bracing systems in 1979.

a. Lateral Bracing Connections.

The lateral bracing connections, although generally in good condition, continue to show the worst corrosion of any bridge element. Because of the nature of the connections (horizontal and oriented such that moisture cannot escape easily), minor to moderate rusting is evident, even on gusset plates replaced in 1979. The worst deterioration is at horizontal gusset plates. Sand and bird excrement deposited in these areas retain moisture, which accelerates rusting of the steel. Particular attention to timely and thorough cleaning and painting of these plates is essential to maintain adequate condition.

b. Lateral Bracing Members.

In Spans 1, 2 and 3 lateral bracing members consist of four angles connected by lacing bars. In the approach spans (Spans 4, 5, 6 and 7), lateral bracing members originally consisted of two angles back to back. All upper lateral bracing (reported previously to be bowed vertically from either its own weight or excessive compressive forces) has been strengthened by adding an MC 10 x 28.5 channel to existing back to back angles. All original lower lateral bracing (back to back angles) have been replaced with more substantial back to back 5 x 5 x 3/8 angles. New connecting gusset plates and high strength bolts were included as required.

The overall condition of the horizontal bracing connections and members, although showing some degree of rusting, is still good. As noted previously, the worst rusting is at horizontal gusset plates, although areas of minor rusting is also quite prevalent between outstanding legs of back to back angles. The build up of bird excrement with subsequent deterioration of gussets and member ends continues to be an on going problem which requires particular attention during cleaning and painting, and may require periodic rehabilitation. The problem is most acute at the ends of lower horizontal struts. See Photos BC7-21 and BC9-21, page A-13, and B5-17, B7-5, and B3-21, page A-17. Numerous horizontal struts exhibit up to moderate rusting along their length, with particular problem areas located at Span 1 upper strut locations where the strut axis is rotated and water cannot drain from the trough formed in the lower leg of the upper channel. See Photos BC7-25, BC3-20, and BC9-2, page A-2.

c. Sway Bracing.

The overall condition of the sway bracing is good. Deteriorated sway bracing members and connections were replaced in 1979 and except for minor areas of rusting, no particular areas of distress were noted. The condition of bracing members and connections is shown in Appendix A, pages A-12 to A-15 for Span 1, and pages A-16 to A-19 for Spans 2 - 7.

4. Hangar Cables.

The hangar cables are located at each lower panel point in the main span (Span 1) from panel point 11 to 11', and support the floor beams for this portion of Span 1. There are two cables at the end of each floorbeam, varying in length from 18 to 73 feet, suspended from the lower panel points of the lower chords of the arched truss. New cables were installed in 1986.

The hangar cables were inspected from the upper socket connection at the lower chord panel point, down to the lower socket connection at the wind chord level. All cables and connections were found to be in excellent condition with no signs of wear. Because of their age and good condition, no further testing was considered necessary at this time. The condition of the hangar cables is shown in Appendix A, pages A-20 to A-22.

5. Floorbeams and Stringers.

The roadway deck is supported by nine lines of stringers, 24 or 27 inch deep beams (depending on span length) spaced at 5 feet. The stringers frame into 60 inch deep floor beams which span 50 feet between trusses and are spaced at distances from 26 to 44 feet apart.

The condition of the floorbeams is very good, with only isolated areas of minor rusting noted. Areas of serious deterioration previously reported at the east and west ends, in the top flanges along sidewalk channel clip angles, and outstanding legs of stiffener angles, were all repaired in 1979. Any deteriorated rivets were also replaced with high strength bolts at that time. All repairs are in very good condition. Areas of accelerated rusting do occur at locations beneath roadway joints, particularly at floorbeam ends. Examples of this can be seen in Photos B22-20, B22-23, B14-2 and B22-18 on page A-27; and also in Photos B46-22, B46-20, and B45-10 on page A-29.

The condition of stringers is also very good, with the only exception being rusting along the top flanges and webs of exterior stringers on both sides of the bridge. Areas of deterioration previously reported on flanges of exterior stringers and occasionally into the webs were repaired in 1979.

Deteriorated rivets were also replaced with high strength bolts at that time. All repairs are in very good condition. The condition of floorbeams and stringers is shown in Appendix A, pages A-27 and A-29.

6. Suspended Floor Bracing (Span 1 only).

The suspended floor bracing consists of a system of diagonals and longitudinal windchords forming a horizontal truss between panel points 10 and 10'. Suspended floor bracing members were found to be in generally good condition with the exception of the ends near panel points 10 and 10'. In the past leakage through the old, open roadway joint system above had been a continuing source of corrosion of the steel. Despite extensive replacement of severely deteriorated laces and rivets, and installation of new roadway joints, all in 1979, accelerated corrosion appears to still be a problem at these locations. The corrosion appears to be somewhat greater at 10 than 10', and occurs primarily at the east and west ends of the truss, an indication that leakage is not necessarily occurring through the roadway joints. Other possible leakage routes are from the sidewalk and curb surfaces down the exterior face; through bituminous pavement and curb intersection where the waterproofing membrane is lapped up on to the uneven face of the granite curb; or possibly at scuppers located just upgrade of panel points 10 and 10', where the waterproofing membrane is similarly lapped up on to the vertical face of the scupper. The condition of the suspended floor bracing is shown in Appendix A, pages A-23 to A-26.

7. Sidewalk and Curb Supports.

The condition of the sidewalk and curb supports were found to be very good. Isolated areas of rusting at exterior channel locations were noted. Areas of previous deterioration at clip angles supporting channels at floorbeams and at angles and connecting bracing gussets were repaired in 1979 and appear to be in good condition. The condition of sidewalk and curb supports is shown in Appendix A, page A-32.

8. Deck.

The original lightweight reinforced concrete deck system was replaced in 1979 with a new lightweight concrete filled steel grid deck placed on galvanized steel stay-in-place forms. A one piece, elastomeric waterproofing membrane and a 2 inch bituminous concrete wearing surface were placed over the deck to provide protection from chloride intrusion and a smooth wearing surface.

Although the deck underside is not visible because of the stay-in-place forms, there is no physical evidence of any deck deterioration, and at this time it is reasonable to assume that

the deck is in very good condition. Some rusting of the stay-in-place forms was noted at the east and west ends at panel points 10 and 10' as noted in the previous section. However, this is not considered to be associated with a deck problem. The condition of the underside of the stay-in-place forms is shown in Appendix A, page A-33.

9. Expansion Joints.

On the Bourne Bridge Deck there are eight locations at which provision for movement was provided in the original design. Prior to 1979 an open joint system was used, and during that time leakage through the existing steel finger plate joints was cited as the most significant and continuing cause of deterioration of the underlying structural steel. Because of this problem, a substantial percentage of the steel repairs during the 1979 rehabilitation was to steel below joint locations. New joints were installed as part of the 1979 work and consisted of segmental traffic seals (Transflex types) at larger joints and one piece, reinforced strip seals at smaller joint openings. The type of joint possible was restricted by the available space between the top of the roadway and the top of the floorbeams. The location of these joints, the lengths of spans contributing to expansion at each and the type of joint now in place are listed below:

Location	Span Length for Expansion	Joint Type
South Abut.	0 (Fixed)	3" Reinf. Neoprene Seal
Pier 5	240 feet	4" Reinf. Neoprene Seal
Pier 3	666 feet	Transflex 900
PP 10	0 (End of Susp. Span)	4" Reinf. Neoprene Seal
PP 10'	0 (End of Susp. Span)	4" Reinf. Neoprene Seal
Pier 4	1252 feet	Neoprene Box Seal
Pier 6	208 feet	4" Reinf. Neoprene Seal
North Abut.	0 (Fixed)	3" Reinf. Neoprene Seal

The overall condition of the existing roadway joints is considered to be good. The exposed wearing surfaces show no evidence of excessive wear or failure of anchorages. The underside appear to be in satisfactory condition with the adjacent steel showing no greater degree of rusting than in other areas, with the exception of the areas beneath the joints at panel points 10 and 10' as indicated in Section 6, Suspended Floor Bracing.

10. Bituminous Wearing Surface/Waterproofing Membrane.

A new waterproofing membrane and bituminous concrete wearing surface was placed on the truss spans in 1979 and on the abutment decks in 1988. The overall condition of the membrane and wearing surface appears to be good. One recurring problem area exists around scupper inlets where the membrane was lapped up and sealed to the vertical sides of the scupper inlet. In several locations leakage between the interface of the scupper sides and the bituminous wearing surface is evident from the active rusting of scupper elements and supporting members (See Section 12e, Scuppers).

11. Paint.

The original paint system on the bridge consisted of two coats of red lead and linseed oil and a finish coat of white lead and linseed oil. Subsequent repainting have been performed with a ready mixed paint consisting of aluminum paint, tung oil and phenolic varnish. The steel within 10 feet of the roadway joints has been coated with coal tar epoxy. The most recent painting was completed in 1980 using a three coat system consisting of a Borosilicate Primer, a Borosilicate Intermediate Coat, and an Aluminum Borosilicate Finish Coat.

The existing paint on the Bourne Bridge is currently in fair to poor condition. Flaking, blistering and surface rusting is evident to some degree on the majority of members and connections. Particular problem areas continue to be horizontal gusset plates, areas where water has leaked through roadway joints or through scuppers, or exterior locations where water has run off sidewalk or curb surfaces to members below. Poor quality of surface preparation prior to previous repainting is a contributing factor to continued deterioration. The majority of steel work consists of built up members with numerous lacing bars, stay plates, rivets (or relatively new high strength bolts) and gusset plates. This type of steel construction presents serious difficulties in cleaning prior to paint application. Areas such as the interior of built up truss members present particularly difficult access problems and appear to have not received adequate attention during previous repainting contracts. The majority of photos in Appendix A substantiate the overall paint condition.

12. Miscellaneous.

a. Catwalk.

The main catwalk runs full length along the underside of the bridge between abutments and consists of a steel angle supporting frame and a steel grating walking surface. A second catwalk runs along the lower chords of the west side of Span 1 from L10'W to L16W covering the northwest quadrant of the arch portion of the structure. Previously deteriorated angles and grating sections have been repaired or replaced as necessary in 1979. The present condition of the supporting angles is good with no evidence of distress noted. Some grating sections (10-15%) show minor deterioration and section loss and should be replaced.

b. Light Standards.

The overall condition of the light standards is good. Minor areas of rusting consistent with that of other steel members was noted.

c. Suicide Fence.

Previously existing palings and pipe supports were removed from the original railing system on both sides of the bridge in 1979. Existing post and channel rails were retained to support new palings spaced at 6 inches on center and extending 11 feet 9 inches above the sidewalk or curb level to provide a new suicide deterrent system. The overall condition of the members of the suicide fence system is very good with no areas of distress noted.

d. Access Ladders.

Access ladders are provided at eleven locations on the bridge. There are two ladders at each abutment(one inside, one outside), one at each of six pier locations extending from the underdeck catwalk down to the top of each pier, and one providing access from the abovedeck catwalk to the navigation light at panel point U16W. All ladders are vertical with safety rails permanently attached to the ladders to accommodate safety belts. The above deck access ladder is provided with a safety cage in addition to the safety guide. Deteriorated brackets which attach the ladders at several locations, and which were previously reported to have some degree of section loss, were replaced in 1979. The overall condition of the access ladders is good, with only minor rusting noted.

e. Scuppers.

On the deck of the Bourne Bridge there are a total of 50 Scuppers in the design to divert water from the structural steel. The complete scupper system consists of a 1' 2" square grated inlet which necks down to 6 inches below the deck, a galvanized steel reducing collar, supporting channels framed into deck stringers, and a 6 inch diameter galvanized steel drain pipe which terminates 6 inches below the bottom of existing truss members.

In general, the scupper system is in good condition, with one exception. As noted previously in Section 10, leakage appears to be occurring around scuppers based on accelerating rusting of stay-in-place forms, supporting channels, and the top flanges of adjacent stringers at scupper locations. This condition occurs at approximately half of the scupper locations. It is assumed that this leakage is along the interface between the exterior of the scupper inlet and the bituminous wearing surface. At this interface the waterproofing membrane was lapped up and sealed to the vertical sides of the inlet prior to placement of the bituminous wearing surface, and in affected areas this seal is apparently not functioning properly. This problem could eventually result in deterioration of the adjacent deck and, therefore, should be addressed in a timely manner. The condition of affected scupper locations is shown in Appendix A, pages A-23 and A-30.

f. Sidewalk/Curb.

On the west side of the bridge there is a 6'- 8" reinforced concrete sidewalk, and on the east side, a 2'- 0" reinforced concrete curb, both with 5 inch granite curbings. New reinforced concrete was placed in 1979, and a bituminous waterproofing membrane with embedded fine aggregate was applied to both surfaces in 1984. The existing condition of the sidewalk and curb appears good, and leakage is no problem based on the condition of the supporting steel below (See Appendix A, page A-31). However, along the surface of the sidewalk, there are numerous locations where both aggregate and membrane have been worn away by pedestrian traffic. In a few locations the bare concrete has become exposed. Replacement of the waterproofing membrane is recommended.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. General

In general, the condition of the Bourne Bridge is considered to be good. All fracture critical elements in Spans 1 - 7 are in good condition with no sign of distress (See next section). The major rehabilitation begun in 1979 and completed in 1980 has eliminated all structural deficiencies which had existed previous to that time. In addition, all hangar cables were replaced in 1986. For additional reference, a chronology of all maintenance and rehabilitation contracts during the life of the structure is listed in Figure 5.

B. Structure Importance

In addition to normal structure considerations, the Bourne Bridge possesses certain attributes which magnify its importance and criticality to an even higher level as listed below:

(1) The Bourne Bridge serves as one of only two vehicular accesses to Cape Cod, and as such, it is subjected to a high traffic density of which a substantial portion consists of truck traffic. Because of the traffic volume and its nature (high percentage of tourists), the bridge's ability to continue to safely carry current and future loads is paramount to both the Corps of Engineers and the general public.

(2) The trusses of both the main span and the approach spans are considered to be fracture critical. They are so defined because each is a two parallel truss system with no load path redundancy; that is, failure of one truss would most certainly result in the collapse of that particular span. This may, or may not, be totally accurate for the main span which is statically indeterminate due to its continuity. However, at present AASHTO chooses to neglect structural redundancy (continuity) and requires classification of all two truss systems as non-redundant, therefore fracture critical. Thusly defined, considering individual members of the structure, there are a total of 188 fracture critical elements as identified in Figure 6 and summarized below:

SPAN	East Truss/# FCM	West Truss/#FCM	Total FCM
1	22	22	44
2-7	12/span = 72	12/span = 72	144
Total	94	94	188

(3) The structure was originally completed in 1933, making it approximately 60 years of age.

(4) The structure is subjected to a corrosive chloride environment, both from deicing chemicals used on the deck during winter months, and also from its constant exposure to the salt water of the Cape Cod Canal below.

Because of this elevated degree of importance, emphasis in the following areas becomes even more critical:

(a) Maintenance requirements (particularly cleaning and painting) require timely and thorough implementation.

(b) Major remedial recommendations require prompt identification, programming and implementation.

(3) Future inspections and required analyses, testing or studies should be comprehensive in all aspects, complete to the extent that all criteria are satisfied, and timely in their performance.

C. Inspection Summary/ Existing Deficiencies.

Component/Item	Remarks
Abutments	Deterioration of patches on bridge seat; areas of deterioration on brestwalls, wingwalls, and parapets; areas of unsound concrete on parapets.
Channel Piers	Mortar loss in joints of granite stone facing.
Intermediate Piers	Deterioration of patches along top edges of Piers 3, 4 and 6; surface staining and surface abrasion on pier tops.
Paint System	Fair to poor condition with flaking, blistering and surface rusting in most locations; steel work consists of built up members with numerous lacing bars, stay plates, rivets or bolts, and gusset plates, presenting particular access difficulties for cleaning and repainting operations; evidence of inadequate surface preparation during previous painting contracts; areas requiring particular attention: interior of built up members, horizontal gussets, ends of lower horizontal struts, upper horizontal struts (Span 1), ends of suspended bracing near panel points 10 and 10'.

Catwalk	Some grating sections (10-15%) with moderate rusting and minor section loss.
Scupper	Apparent leakage at interface between scupper inlet and bituminous wearing surface where waterproofing membrane is lapped on to side of inlet; accelerated rusting of stay-in-placeforms,supporting channels, and tops of adjacent stringers beneath affected scupper locations (approximately 25 of 50 locations).
Sidewalk/Curb	Deterioration of existing waterproofing membrane in numerous locations.

D. Recommendation Priority.

Listed below is a categorization system for recommended remedial action base on the degree of priority as indicated:

Priority	Definition
1	Highest priority, where immediate work is required to maintain or restore structural integrity. Recommendations falling into this category may require limiting bridge loads until implemented.
2	Remedial work which is necessary to correct deterioration or conditions which may affect structural integrity in the future.
3	Remedial work where structural integrity has not been affected, but where aesthetics or safety is a consideration.
4	Analyses, studies or testing required to satisfy NBIS criteria or considered necessary to properly evaluate structure condition.

E. Recommendations.

Based on the overall inspection findings, there is no recommended remedial work which falls into Priority 1. The recommendations based on this inspection fall into Priorities 2 - 4, and are listed below with priorities and estimated costs:

1. Clean and repaint all structural steel. Sufficient attention should be given to ensure adequate surface preparation and coverage, particularly in areas of difficult access as indicated above.

Priority	2
Est. Cost	$2,500,000

(It should be noted that an FY 92 contract has been awarded for this work, and work has already begun).

2. Assess the condition of leakage around scuppers, and design a repair system to eliminate the problem. One possible solution is the removal of the bituminous wearing surface from around scuppers, patching of existing waterproofing membrane, and resealing around inlet to achieve a more positive seal. Process would most likely entail the following:

a. Condition survey of all scuppers to define extent of affected scuppers.
b. Design necessary repairs; prepare plans and specifications.
c. Implement repairs.

Priority		2
Estimated Cost	a.	$25,000
	b.	$20,000
	c.	$150,000

3. Design and implement a procedure to rehabilitate the areas of concrete deterioration on substructure elements. Typical work should include removing and repairing or replacing all unsound concrete as necessary, possible application of penetrating sealer or protective coatings, repointing mortar joints, etc. Process would entail the following:

a. Condition survey of all concrete elements.
b. Design repairs; prepare plans and specifications.
c. Implement repairs.

c. Implement repairs.

Priority		2/3
Estimated Cost	a.	$40,000
	b.	$30,000
	c.	$300,000*

*Estimated cost for items 2 and 3 may vary considerably depending on the results of condition surveys.

4. Remove existing waterproofing membrane from sidewalk (16,000 SF) and curb (5800 SF) and replace with a new waterproofing system.

Priority	2
Estimated Cost	$200,000

5. Replace deteriorated catwalk gratings; provide a safety cage around access ladders to Piers 1 -7.

Priority	3
Estimated Cost	$100,000

6. Perform rating analysis on structure to determine actual inventory and operating ratings as required by NBIS.

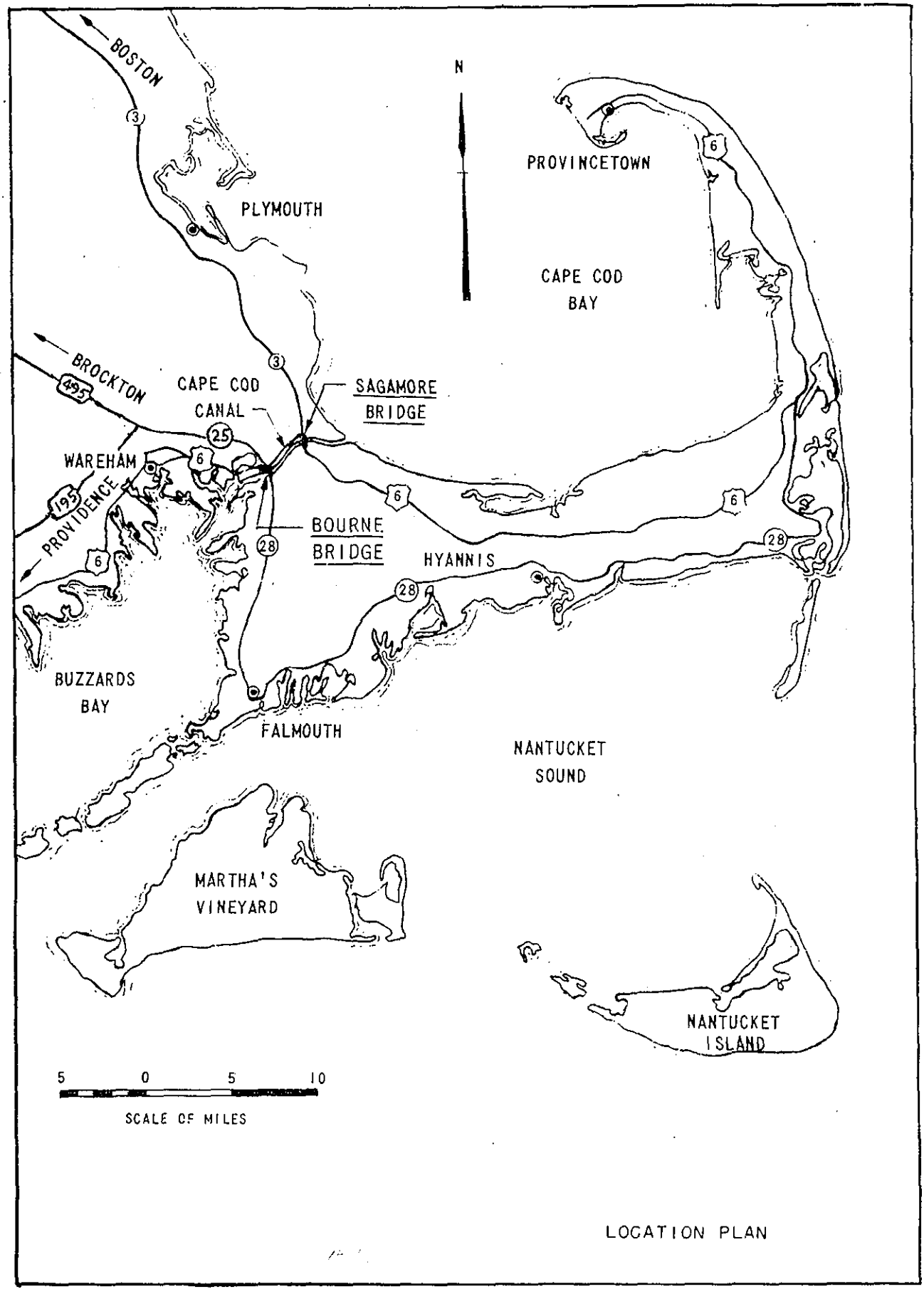
Priority	4
Estimated Cost	$50,000

7. Remove segments of stay-in-place forms to allow a more accurate assessment of condition of deck underside; 10 locations, 5 of which should be adjacent to areas of accelerating rust below scuppers. This should be performed concurrently with next inspection.

Priority	4
Estimated Cost	$5000

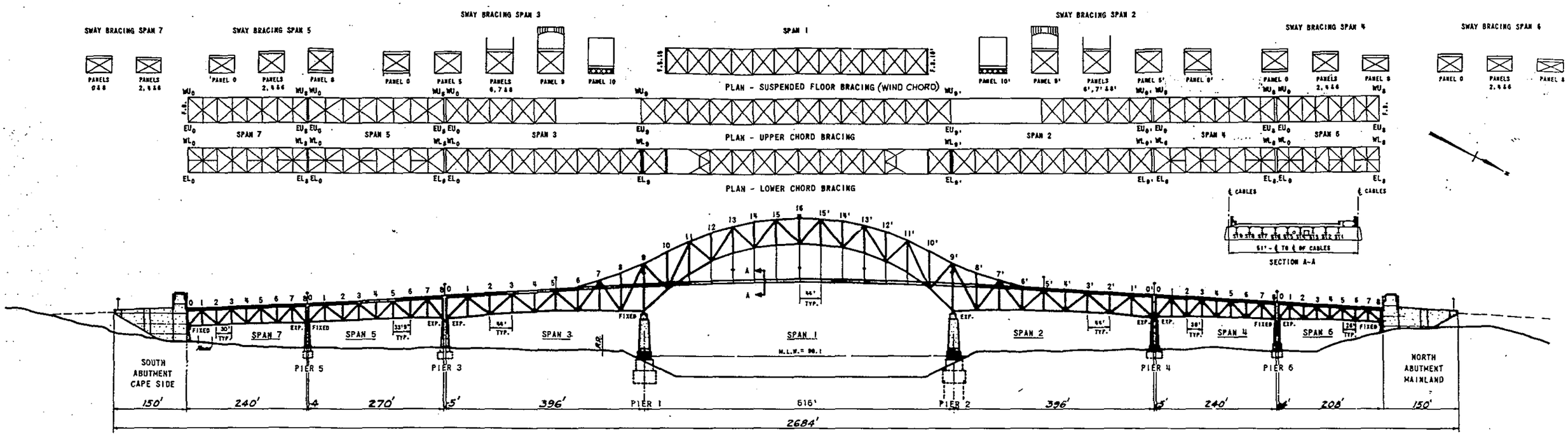
8. During the next inspection, particular attention should be paid to the condition of the roadway joints and the underlying steel beneath panel points 10 and 10' to determine if significant leakage is occurring through these joints.

Priority	4
Estimated Cost	Included in Cost of Inspection



LOCATION PLAN

Figure 1



ELEVATION

LEGEND

N = NORTH	ST = STRINGER
S = SOUTH	SW = SIDEWALK
E = EAST	W.C. = WIND CHORD
W = WEST	M.H. = MAN HOLE
F.B. = FLOOR BEAM	
L = LOWER CHORD PANEL POINT	
U = UPPER CHORD PANEL POINT	
MLW = MEAN LOW WATER BASED ON MSL = 100	

Figure 2

BOURNE BRIDGE

STRUCTURES INSPECTION FIELD REPORT

Figure 3

city/town	bridge dept. no.	8-structure no.	90-date inspected
BOURNE		CENED00251MA001	JULY-OCT 91

2-dist.	104-highway system	22-owner	27-year built	106-year rebuilt	11-milepoint
		C OF E	1933	1979	

43-structure type: STEEL TRUSS (310)	quality control engineer: N. FORBES
07-facility carried: MA ROUTE 28	team leader: J. COLUCCI
06-features intersected: CAPE COD CANAL	team members: M. WALSH, F. FUNG, F. KEEFE

item 58	8
DECK	
1. Wearing Surface	8
2. Deck-Condition	IA
3. Stay in Place Forms	8
4. Curbs	7
5. Median	NA
6. Sidewalks	7
7. Parapet	6
8. Railing	8
9. Anti Missile Fence	NA
10. Drains	6
11. Lighting Standards	
12. Utilities	
13. Deck Joints	
14. Approach Settlement	

item 59	8
SUPERSTRUCTURE	
1. Bearing Devices	8
2. Stringers	8
3. Diaphragms	NA
4. Girders or Beams	NA
5. Floor Beams	8
6. Trusses	8
7. Rivets or Bolts	8
8. Welds	NA
9. Collision Damage	8
10. Load Deflection	7
11. Member Alignment	8
12. Load Vibration	7
13. Paint-Epoxy	6
14. Year Painted	79
15. Under Clearance 135 ft 0 in	
Clearance Signs ☐ yes ☑ no	

item 60	8
SUBSTRUCTURE	
1. Abutments	
a-Wings	7
b-Backwall	7
c-Bridge Seats	7
d-Breastwall	7
e-Footings	NA
f-Piles	IA
g-Erosion	8
h-Settlement	8
2. Piers or Bents	
a-Caps	7
b-Column	8
c-Web	8
d-Footing	8
e-Piles	NA
f-Scour	8
g-Settlement	8
3. Collision Damage	8
4. Hydraulic-Adequacy	8

Actual Posting	H	3	3S2	Single
	-	-	-	16 TONS/AXLE
Recommended Posting From Rating Book	-	-	-	16 TONS/AXLE

SIGNS IN PLACE Y or N	at bridge	advance
	Y	Y
LEGIBILITY	8	8

Overhead Signs (attached to bridge) ☐ yes ☑ no

1. Welds	NA
2. Bolts	NA
3. Condition	NA

Item93b U/W Inspection Date: NA

ITEM 61-channel and channel protection 9

1. channel scour	9	5. rip rap or slope paving	NA
2. embankment erosion	9	6. effectiveness	NA
3. fender system	NA	7. debris	9
4. spur dikes & jetties	NA	8. vegetation	9

36-Traffic Safety features

	36	condition
1. bridge railing	1	8
2. transitions	1	8
3. approach guardrail	1	8
4. guardrail terminal	1	8

X=UNKNOWN NA=NOT APPLICABLE IA=INACCESSIBLE

```
      HIGHWAY  BRIDGE  STRUCTURE  INVENTORY  AND  APPRAISAL      02/24/93
********** IDENTIFICATION **********
  1 State - Massachusetts                    251
200 COE MSC -DIS/DIV IS UNDEFINED.
201 COE District -DIS/DIV IS UNDEFINED.
202 COE Bridge Number : CENNED0251MA001
  8 STRUCTURE NUMBER  : CENNEDMA2510001
  5 Inventory Route   -on      131000280
  2 Highway Dist.     :              00
  3 County Code:000  4 Place code:
  6 Features Intrsct:CAPE COD CANAL
  7 Facility Carried:MA ROUTE 28
  9 Location : JUNCT MA RTES 25,28, & 6
 11 Milepoint         :
 16 Lat:  D  0.0'    17 Long:   D  0.0'
 98 Border Br State :
 99 Border Br Stru #:
****** STRUCTURE TYPE & MATERIAL ******
 43 Stru Main Material- Steel
    Type- Truss - thru                      310
 44 Stru App  Material- Steel
    Type- Truss - Deck                      309
 45 # of Main Spans :                       003
 46 # of App Spans  :                      0004
107 Deck Stru       -Closed grating          4
108 Wearing Surf/Protective Sys type
   A Wearing Surface - Bituminous           6
   B Membrane        - Pfmd fabric          2
   C Deck Protection - None                 0
********** AGE & SERVICE **********
 27 Year Built          :                 1935
106 Year Reconstructed  :                 1978
 42 Type of Service on -hyw/pedstn
    under: Waterway                         55
 28 Lanes On Stru: 04    Under Stru: 00
 29 ADT                 :                300000
 30 Yr of ADT : 91  109 Truck ADT : 20%
 19 Bypass, Detour Length (miles)          10
********** GEOMETRIC DATA **********
 48 Length of Max Span (ft)     :         6160
 49 Structure Length   (ft)     :       002684
 50 Curb/Sidewalk Width L:06.7' R:01.7'
 51 Bridge Width, Curb-to-Curb  :       040.0'
 52 Deck Width, out-to-out      :       048.3'
 32 Approach Rdwy Width         :         048'
 33 Bridge median - No median               0
 34 Skew : 00 deg      35 Stru Flared: 0
 10 Inventory Rt Min Vert Clrn  :       99'99"
 47 Inv. Rt Total Horz Clrn     :       40.0'
 53 Min Vert Clrn over Rdwy     :       03.5'
 54 Min Vert Underclearance     :       N0000'
 55 Min Lateral R Underclrnc    :       N999'
 56 Min Lateral L Underclrnc    :        999'

(App C) Sufficiency Rating = 055.1
        Status =  Functional obselete
        Data Recorded   12/22/92

******* NAVIGATION DATA *******
 38 Navigation Control       :1
111 Pier/Abutment Protection:
 39 Navigation Vert Clrn     : 135'
116 Vert Lift Bridge Min Clr:     '
 40 Navigation Horz Clrn     :0600'
********* CLASSIFICATION *********
112 NBIS Bridge Length          : Y
104 Hwy System of Inventory Rt: 2
 26 Functional Classification  : 02
100 Defense Hwy Designation    : 0
101 Parallel Stru Designation  : N
102 Direction of Traffic       : 2
103 Temperary Stru Designation:
110 Designated Natl Network    : 1
 20 Toll                       : 3
 21 Main - Military/Corps .    : 70
 22 Owner- Military/Corps      : 70
 37 Historical Significance    : 4
********** CONDITIONS **********
 58 Deck                       : 6
 59 Superstructure             : 8
 60 Substructure               : 8
 61 Channel Protection         : 9
 62 Culverts                   : N
****** LOAD RATING & POSTING ******
 31 Design Load - H 20         : 4
 64 Operating Rating           :
 66 Inventory Rating           : 120
 70 Posting - Unknown          :   5
 41 Stru Open/Posted/Closed    :   P
    - Posted for load
********** APPRAISAL **********
 67 Structure Evaluation       :   7
 68 Deck Geometry              :   3
 69 Underclearance Vert/Horz   :   N
 71 Waterway Adequacy          :   9
 72 Approach Roadway Alignmen  :   5
 36 Traffic Safty Features     :1111
113 Scour Critical Bridges     :   6
****** PROPOSED  IMPROVEMENTS *****
 75 Type of Work               :   000
 76 Length of Stru Imprvmt     : 000000
 94 Bridge Improvement Cost:   000000
 95 Roadway Imprvmnt Cost      : 000000
 96 Total Project Cost (K)     : 000000
 97 Yr of Imprvmnt Cost Est:
114 Future ADT                 : 000000
115 Year of Future ADT         :
********** INSPECTION **********
 90 Insp Date: 10/91   91 Freq: 24mo
 92 Critical Feature Insp    93 Date
   A Frac. Crit Detail :N          /
   B Underwater Insp   :N          /
   C Other Special Insp:N          /
203 Insp Off -DIS/DIV IS UNDEFINED.
204 Inspector:JOE COLUCCI

205 Insp Cost:
```

Figure 4

BOURNE HIGHWAY BRIDGE

CHRONOLOGY OF MAINTENANCE AND REHABILITATION

FY	CONTRACT	WORK	COST($)
1938	PAINTING	Paint superstructure.	14,046
1938	PAVING	Seal coat - Sheet Asphalt.	8,838
1947	PAINTING	Paint superstructure.	34,550
1949	PAVING	Replace bituminous pavement.	29,490
1952	PAINTING	Paint superstructure.	65,879
1958	PAINTING	Paint superstructure.	44,494
1959	REPAIRS	Replace 4 Anchor Bolts(Piers 3&5).	1,468
1963	MAJOR RENOVATION	Resurface roadway and sidewalk, new curbing, replace 5' strip deck concrete, electrical work, new scuppers, concrete repairs, access ladders, platforms and downspouts.	1,039,848
1967	PAINTING	Paint superstructure.	144,400
1969	STRUCTURAL REPAIRS	Pressure grouting of cracks in abutments and piers.	27,455
1971	PAINTING	Paint railings.	21,497
1973	PAINTING	Paint superstructure.	260,970
1976	STRUCTURAL REPAIRS	Repair two stringers, Span 4; replace sidewalk bracket, Span 1.	40,720
1976	CLEAN ABUTMENTS	Remove bird excrement from abutments.	6,835
1976	REPLACE CABLES	Remove two pairs of hangar cables for testing and replace with new cables.	146,370
1979	MAJOR RENOVATION	Remove old deck & replace with lightweight concrete filled steel grid deck; new water-proofing membrane & bituminous wearing surface; strengthening of upper & lower bracing in spans; repair over 250 members; repair or replace over 200 gusset or stay plates; replace approx. 3000 deteriorated rivets with high strength bolts;new roadway joints; paint superstructure.	11,000,000
1984	WATERPROOF	Remove existing & place new waterproofing proofing membrane on sidewalks and curbs.	90,000
1986	REPAIRS (INCL SAG)	New hangar cables; new drainage pipes; new waterproofing on curb and Spans 5 & 7; patch spalls & inject cracks on abutments, piers & parapets; electrical work; paint superstructure.	956,000
1988	REPAIR ABUT. DECKS (INCL SAG)	Remove exist. bituminous w.p. membrane & top 1 1/2" of deck concrete; new 1 1/2" microsilica overlay; new w.p. membrane & bituminous concrete wearing surface.	900,000
1992	PAINT	Paint superstructure (work in progress).	2,500,000

Figure 5

BOURNE HIGHWAY BRIDGE

FRACTURE CRITICAL MEMBERS

SPAN	LOWER CHORDS	UPPER CHORDS	DIAGONALS
1	L12L13	U9U10	L10U9
	L13L14	U10U11	L12U11
	L14L15	U11U12	L14U13
	L15L16	U12'U11'	L16U15
	L16L15'	U11'U10'	L16U15'
	L15'L14'	U10'U9'	L14'U13'
	L14'L13'		L12'U11'
	L13'L12'		L10'U9'
2	L0'L1'	U5'U6'	L2'U1'
	L1'L2'	U6'U7'	L4'U5'
	L2'L3'	U7'U8'	L6'U7'
	L3'L4'	U8'U9'	L8'U9'
3	L0L1	U5U6	L2U1
	L1L2	U6U7	L4U5
	L2L3	U7U8	L6U7
	L3L4	U8U9	L8U9
4 - 7	L0L1	None	L2U1
	L1L2		L4U3
	L2L3		L4U5
	L3L4		L6U7
	L4L5		
	L5L6		
	L6L7		
	L7L8		

Figure 6

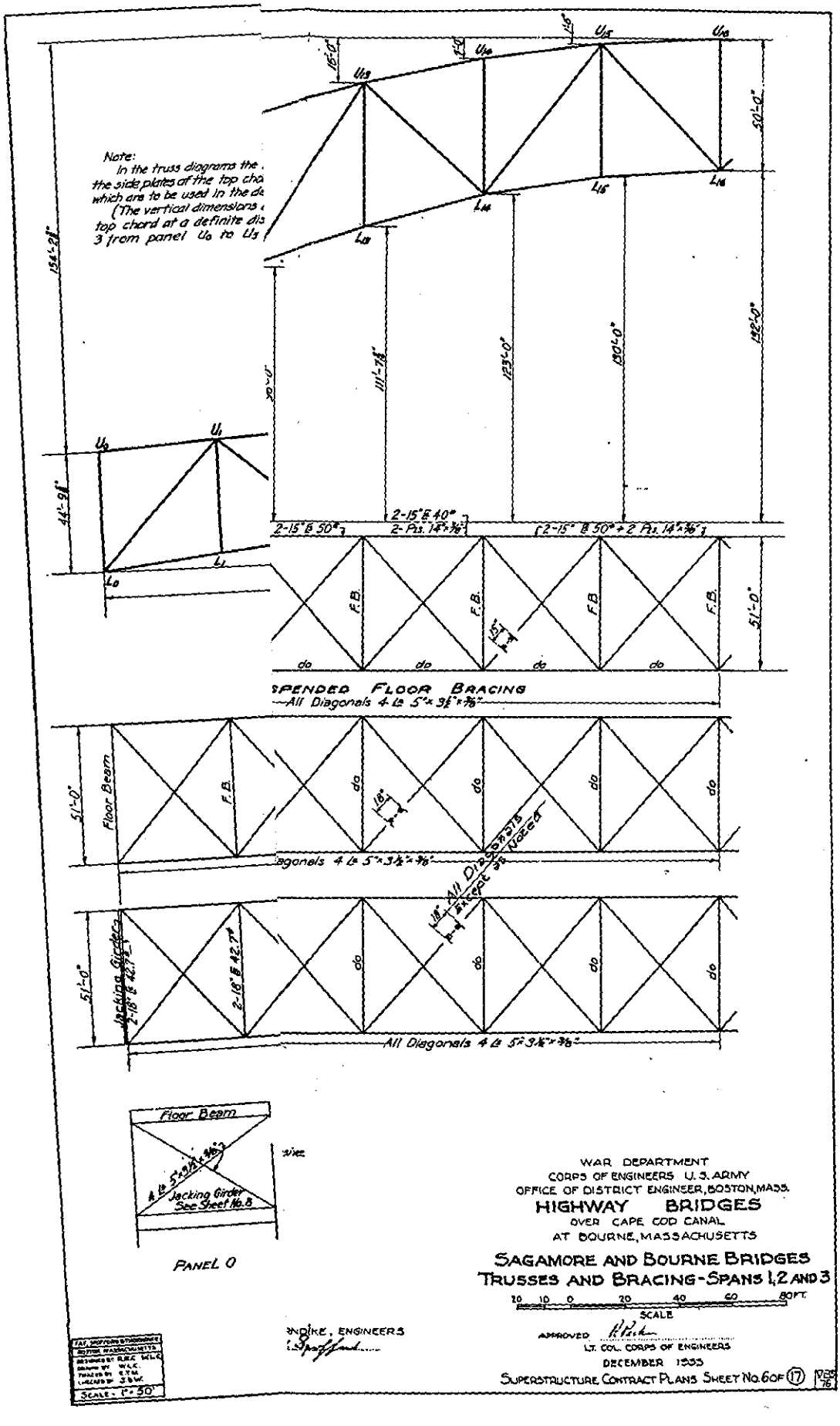

Note:
In the truss diagrams the
the side plates of the top cha
which are to be used in the de
(The vertical dimensions
top chord at a definite dis
3 from panel U0 to U3
154'-9"
44'-9"
50'-0"
111'-7½"
123'-0"
130'-0"
132'-0"
2-15" @ 50#
2-15" @ 40#
2-Pls. 14"x⅜"
[2-15" @ 50# + 2 Pls. 14"x⅜"]
F.B.
do
51'-0"
SPENDED FLOOR BRACING
All Diagonals 4 Ls 5"x 3½"x⅜"
Floor Beam
All Diagonals 4 Ls 5"x3½"x⅜"
All Diagonals except 3rd
Jacking Girder
2-18" @ 42.7#
All Diagonals 4 Ls 5"x3½"x⅜"
Floor Beam
4 Ls 5"x3½"x⅜"
Jacking Girder
See Sheet No. 8
PANEL 0
WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.
HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS
SAGAMORE AND BOURNE BRIDGES
TRUSSES AND BRACING - SPANS 1, 2 AND 3
10 10 0 20 40 60 80 FT.
SCALE
APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933
SUPERSTRUCTURE CONTRACT PLANS SHEET No. 6 OF 17
SCALE - 1"=50'

Figure 7

Note:
In the truss diagrams the vertical dimensions shown are computed to the center of the side plates of the top chord members and not to the neutral axes or working lines which are to be used in the detailing in accordance with the specifications.
(The vertical dimensions are such as to keep the top of the cover plates of the top chord at a definite distance from the crown of the roadway in Spans 2 and 3 from panel U_6 to U_{15} inclusive.)

HALF ELEVATION SPANS 1, 2 & 3.

SUSPENDED FLOOR BRACING
All Diagonals 4 Le 5" x 3½" x 7/16"

TOP CHORD BRACING

LOWER CHORD BRACING

PANEL 0

PANEL 5

PANELS 6, 7 & 8.
SWAY BRACING

PANEL 9

PANEL 10

Notes:
For General Elevations - see Sheets No. 2 and 3
For Deck Sections and Details see Sheets No. 4 and 5
For Stress Sheet see Sheet No. 7
For Truss Details (Spans 1, 2 and 3) see Sheets No. 8 to 11 inclusive.
For Truss Bearings (Spans 1, 2 and 3) see Sheet No. 16
For Detail of Jacking Girder see Sheet No. 8
All elevation are referred to a datum 100 feet below Mean Sea Level

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Lawrence W. Spofford

WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.

HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

SAGAMORE AND BOURNE BRIDGES
TRUSSES AND BRACING - SPANS 1, 2 AND 3

SCALE

APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933

SUPERSTRUCTURE CONTRACT PLANS SHEET No. 6 OF (17)

Figure 7

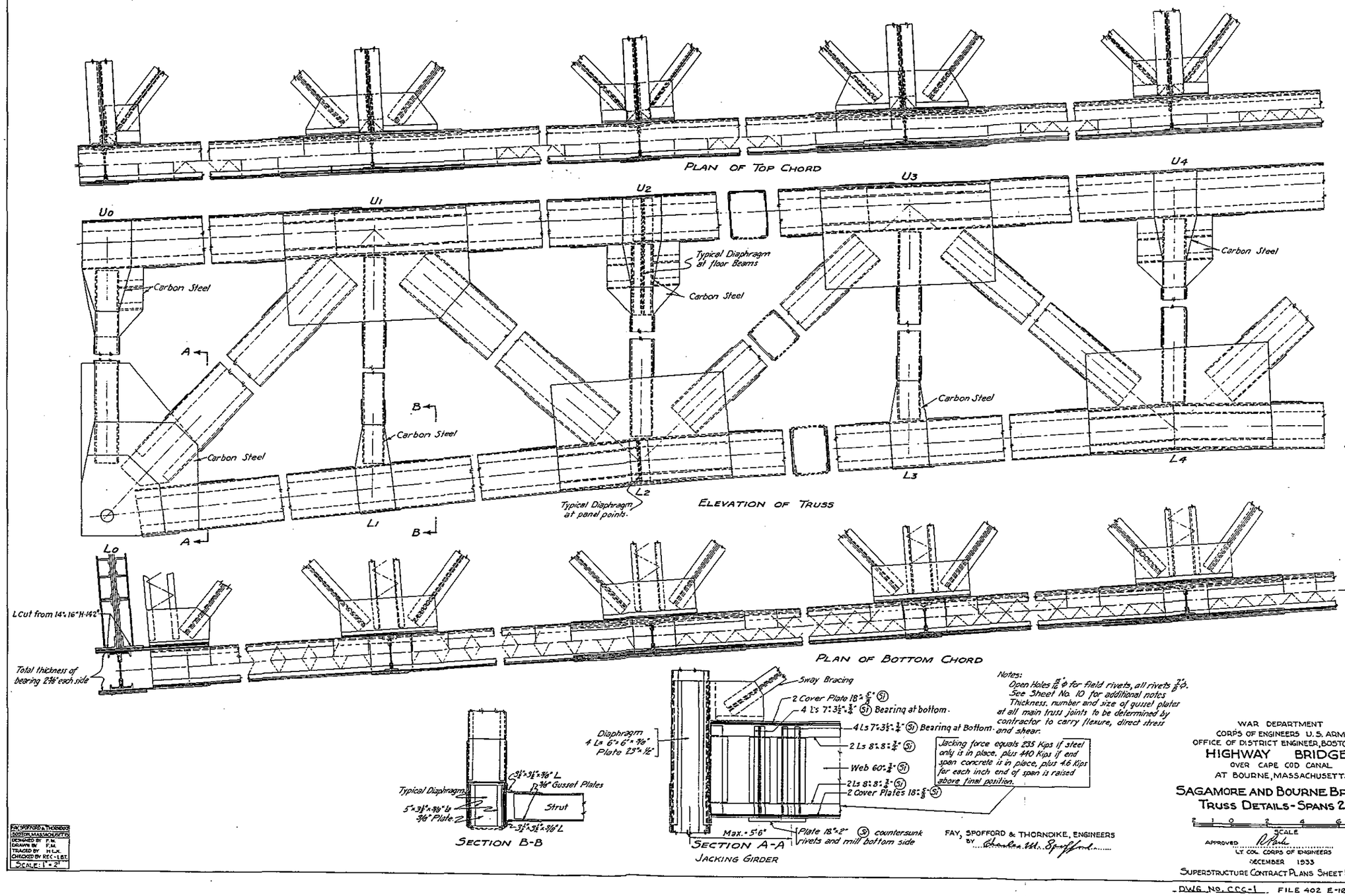
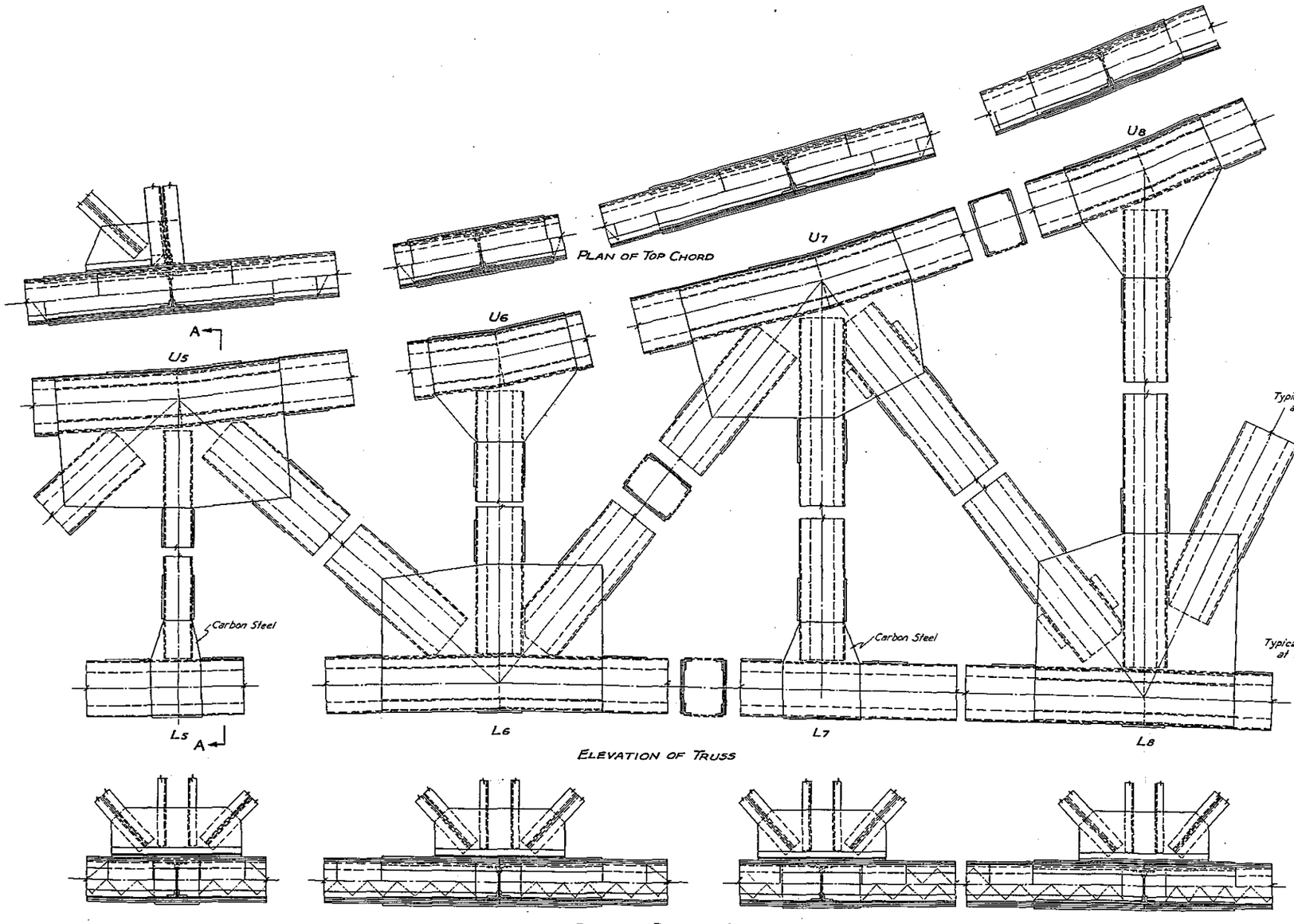

PLAN OF TOP CHORD
U0
U1
U2
U3
U4
Carbon Steel
Typical Diaphragm at floor Beams
Carbon Steel
Carbon Steel
Carbon Steel
Carbon Steel
A
B
B
A
L0
L1
L2
L3
L4
Typical Diaphragm at panel points.
ELEVATION OF TRUSS
L Cut from 14"x16"x1-1/2"
Total thickness of bearing 2-1/8" each side
PLAN OF BOTTOM CHORD
Sway Bracing
2 Cover Plate 18"x 5/8" (S1)
4 L's 7"x3-1/2"x 3/4" (S1) Bearing at bottom.
4 Ls 7"x3-1/2"x 3/4" (S1) Bearing at Bottom and shear.
2 Ls 8"x 8"x 3/4" (S1)
Web 60"x 3/8" (S1)
2 Ls 8"x 8"x 3/8" (S1)
2 Cover Plates 18"x 5/8" (S1)
Diaphragm 4 Ls 6"x 6"x 7/16" Plate 23"x 1/2"
Typical Diaphragm
5"x3-1/2"x 5/16" Ls 3/16" Plate
2-3-1/2"x3-1/2"x 7/16"L
2 7/16" Gusset Plates
Strut
SECTION B-B
Max. = 5'6"
Plate 18"x 2" (S1) countersunk rivets and mill bottom side
SECTION A-A
JACKING GIRDER
Notes:
Open Holes 13/16" ϕ for field rivets, all rivets 7/8" ϕ.
See Sheet No. 10 for additional notes
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.
Jacking force equals 235 Kips if steel only is in place, plus 440 Kips if end span concrete is in place, plus 4.6 Kips for each inch end of span is raised above final position.
FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Charles M. Spofford
FAY SPOFFORD & THORNDIKE BOSTON, MASSACHUSETTS
DESIGNED BY F.M.
DRAWN BY F.M.
TRACED BY M.L.K.
CHECKED BY R.E.C.-L.B.T.
SCALE: 1"=2'
WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.
HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS
SAGAMORE AND BOURNE BRIDGES
TRUSS DETAILS - SPANS 2 AND 3
2 1 0 2 4 6 8 FT.
SCALE
APPROVED
LT COL. CORPS OF ENGINEERS
DECEMBER 1933
SUPERSTRUCTURE CONTRACT PLANS SHEET No. 8 OF (17)
DWG No. CCC-1
FILE 402 E-12-1

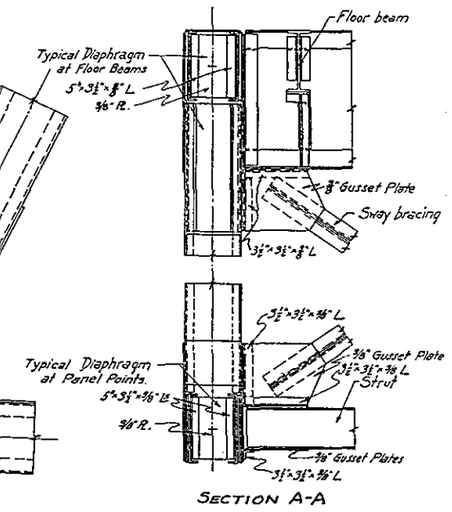
Figure 8



PLAN OF TOP CHORD

ELEVATION OF TRUSS

PLAN OF BOTTOM CHORD



SECTION A-A

Notes:
All rivets to be 7/8"ϕ
See Sheet No. 10 for additional notes.
Rivets in top chord to be countersunk and chipped at Fence Posts in Panel U_5-L_6 and U_6-U_7.
Open holes for field Rivets 15/16" ϕ
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY

FAY, SPOFFORD & THORNDIKE
BOSTON, MASSACHUSETTS
DESIGNED BY P.M.
DRAWN BY P.M.
TRACED BY W.M.P.
CHECKED W. R.E.F. L.B.T.
SCALE: 1" = 2'

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.

HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

SAGAMORE AND BOURNE BRIDGES
TRUSS DETAILS SPANS 2 AND 3

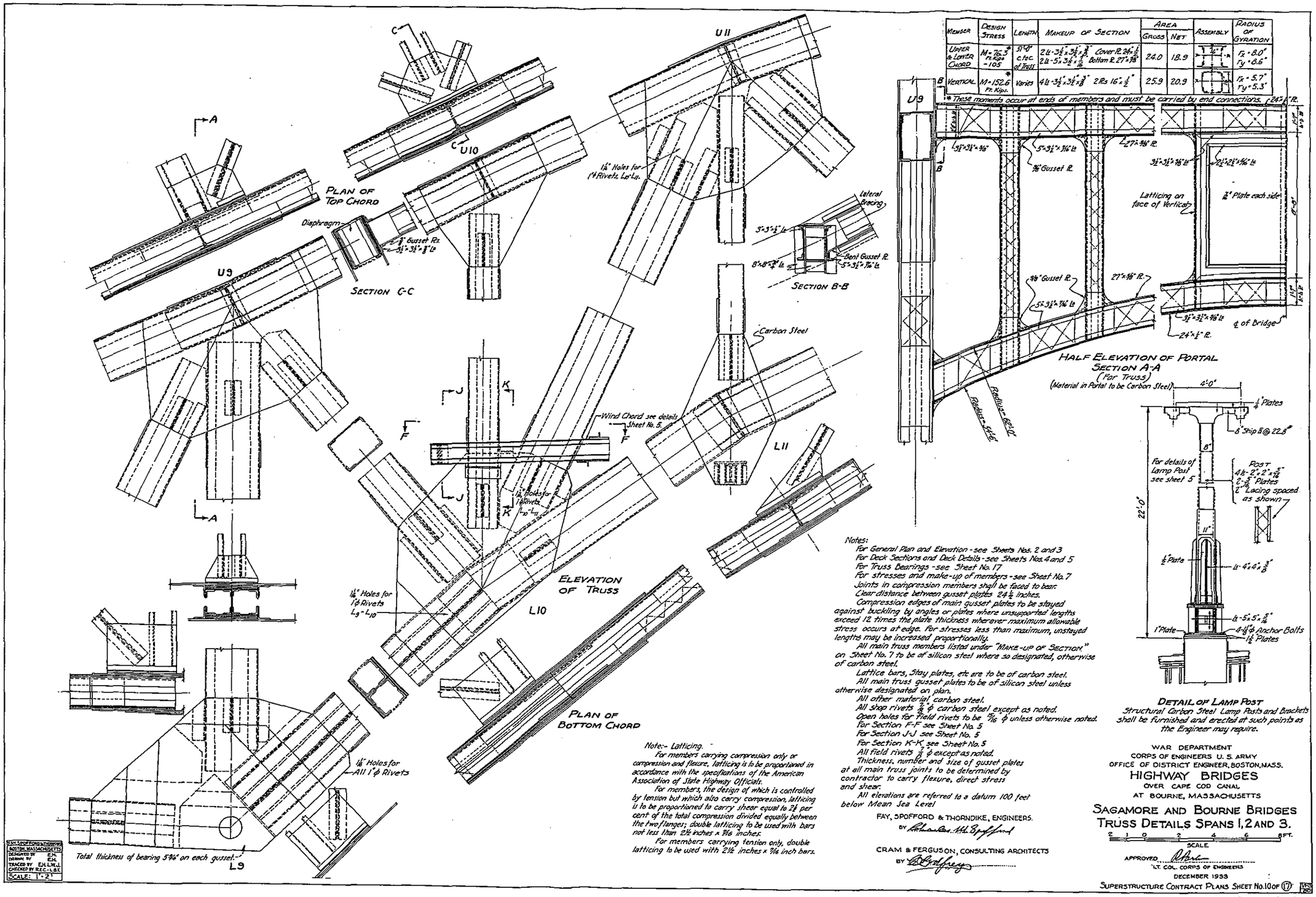
2 1 0 2 4 6 8 FT.
SCALE

APPROVED
LT. COL. CORPS OF ENGINEERS.
DECEMBER 1933

SUPERSTRUCTURE CONTRACT PLANS SHEET No. 9 OF (17)

DWG. NO. CCC-1 FILE 402 E-12-1

Figure 9



Member	Design Stress	Length	Makeup of Section	Area Gross	Area Net	Assembly	Radius of Gyration
Upper & Lower Chord	M = 76.5 Ft. Kips = 105	51'-0" c. to c. of Truss	2 L's - 3½" x 3½" x ⅜" Cover PL 24" x ½" 2 L's - 5" x 3½" x ⅝" Bottom PL 27" x ⅜"	24.0	18.9		rx = 8.0" ry = 8.6"
Vertical	M = 152.6 Ft. Kips	Varies	4 L's - 3½" x 3½" x ⅜" 2 PLs 16" x ½"	25.9	20.9		rx = 5.7" ry = 5.3"

* These moments occur at ends of members and must be carried by end connections.

Notes:
For General Plan and Elevation - see Sheets Nos. 2 and 3
For Deck Sections and Deck Details - see Sheets Nos. 4 and 5
For Truss Bearings - see Sheet No. 17
For stresses and make-up of members - see Sheet No. 7
Joints in compression members shall be faced to bear.
Clear distance between gusset plates 24½ inches.
Compression edges of main gusset plates to be stayed against buckling by angles or plates where unsupported lengths exceed 12 times the plate thickness wherever maximum allowable stress occurs at edge. For stresses less than maximum, unstayed lengths may be increased proportionally.
All main truss members listed under "Make-up of Section" on Sheet No. 7 to be of silicon steel where so designated, otherwise of carbon steel.
Lattice bars, Stay plates, etc are to be of carbon steel.
All main truss gusset plates to be of silicon steel unless otherwise designated on plan.
All other material carbon steel.
All shop rivets ⅞" ϕ carbon steel except as noted.
Open holes for field rivets to be 1⅛" ϕ unless otherwise noted.
For Section F-F see Sheet No. 5
For Section J-J see Sheet No. 5
For Section K-K see Sheet No. 5
All field rivets ⅞" ϕ except as noted.
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.
All elevations are referred to a datum 100 feet below Mean Sea Level

Note:- Latticing.
For members carrying compression only or compression and flexure, latticing is to be proportioned in accordance with the specifications of the American Association of State Highway Officials.
For members, the design of which is controlled by tension but which also carry compression, latticing is to be proportioned to carry shear equal to 2½ per cent of the total compression divided equally between the two flanges; double latticing to be used with bars not less than 2½ inches x 7/16 inches.
For members carrying tension only, double latticing to be used with 2½ inches x 7/16 inch bars.

FAY, SPOFFORD & THORNDIKE, ENGINEERS.
BY

CRAM & FERGUSON, CONSULTING ARCHITECTS
BY

FAY, SPOFFORD & THORNDIKE BOSTON, MASSACHUSETTS
DESIGNED BY E.H.
DRAWN BY E.H.
TRACED BY E.H. L.W.J.
CHECKED BY R.E.C. - L.B.C.
SCALE: 1"=2'

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.

HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

SAGAMORE AND BOURNE BRIDGES
TRUSS DETAILS SPANS 1, 2 AND 3.

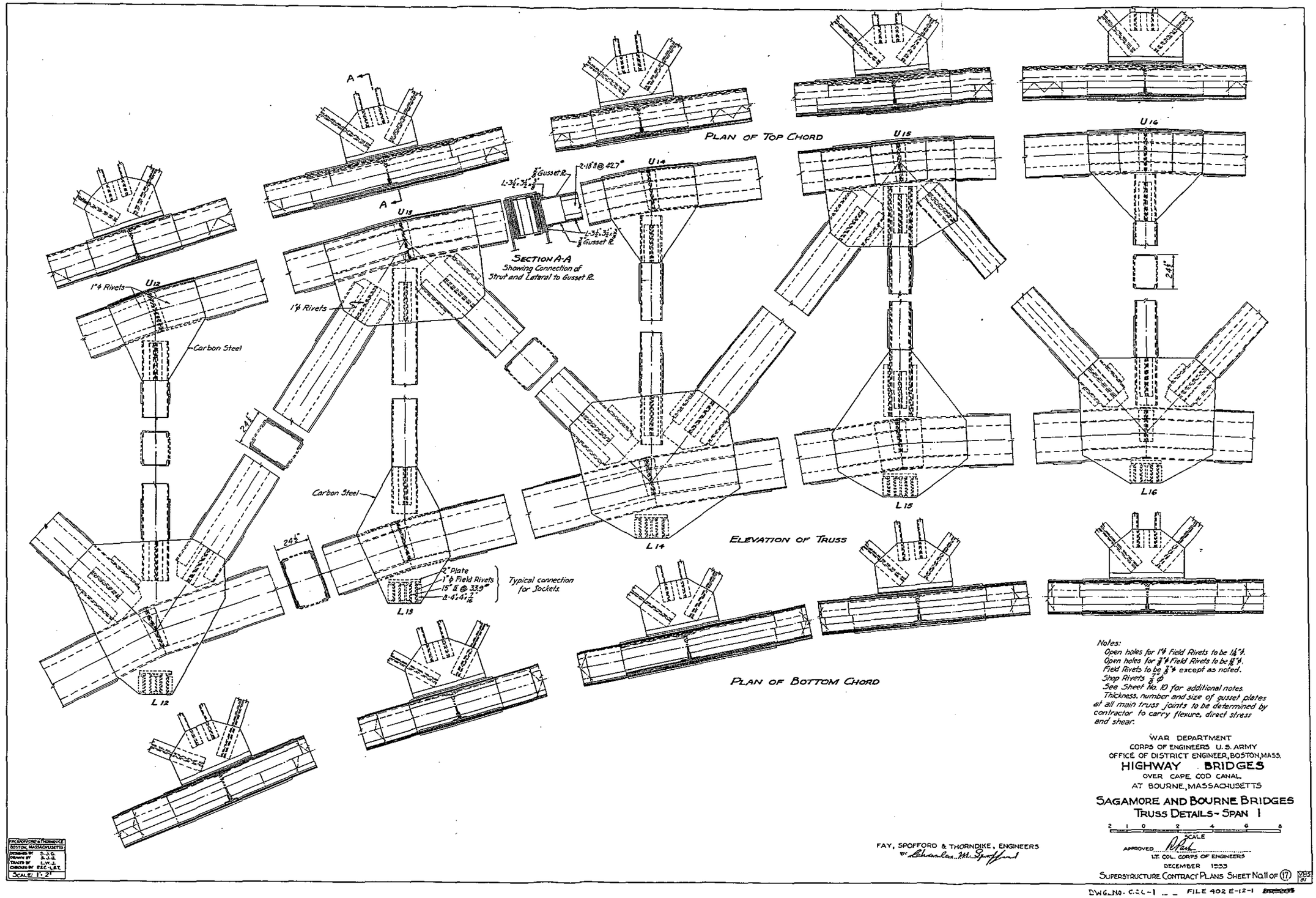
SCALE 2 1 0 2 4 6 8 FT.

APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933

SUPERSTRUCTURE CONTRACT PLANS SHEET No. 10 OF 17 SHEETS

DWG. No. CCC-L FILE 402 E-12-1

Figure 10



Notes:
Open holes for 1"ϕ Field Rivets to be 1⅛"ϕ.
Open holes for ⅞"ϕ Field Rivets to be 1"ϕ.
Field Rivets to be ⅞"ϕ except as noted.
Shop Rivets ⅞"ϕ
See Sheet No. 10 for additional notes.
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.

WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.

HIGHWAY BRIDGES

OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

SAGAMORE AND BOURNE BRIDGES
TRUSS DETAILS - SPAN 1

2 1 0 2 4 6 8 SCALE

APPROVED _____
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933

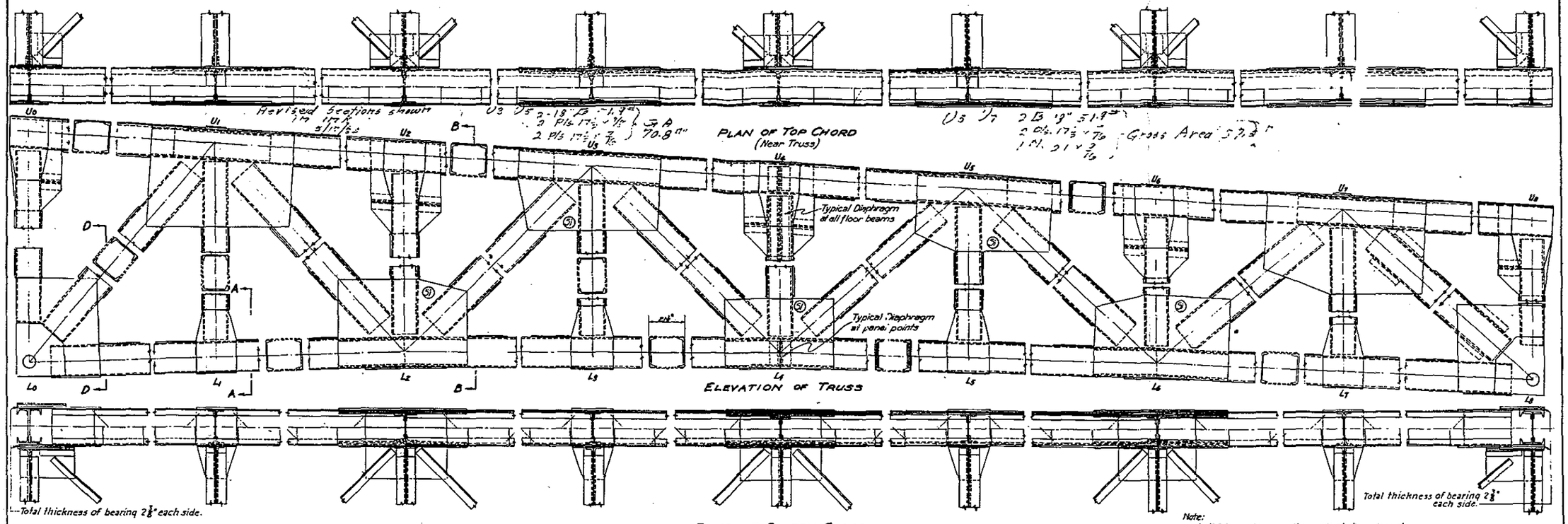
SUPERSTRUCTURE CONTRACT PLANS SHEET No. 11 OF (17)

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Charles M. Spofford

FAY, SPOFFORD & THORNDIKE
BOSTON, MASSACHUSETTS
DESIGNED BY S.J.G.
DRAWN BY S.J.G.
TRACED BY E.W.J.
CHECKED BY E.E.C.-L.E.T.
SCALE: 1" = 2'

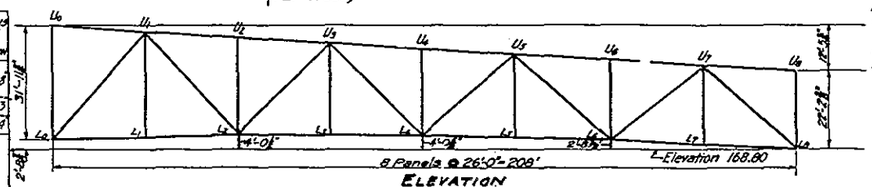
DWG. NO. C-11-1 FILE 402 E-12-1

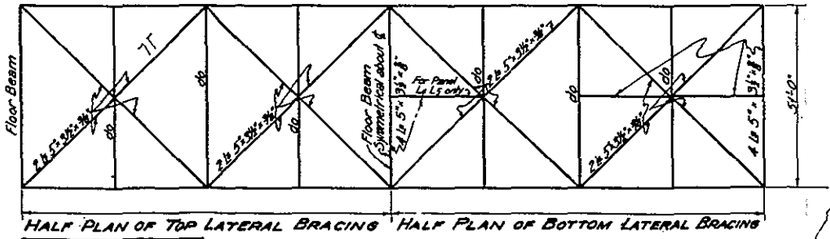
Figure 11

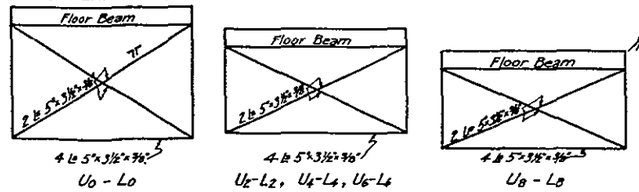


Member	Stresses in Kips: Dead	Live + Impact	Wind	Design Stress	Make-up of Section	Area: Gross	Net	Assembly	Radius of Gyration
U0-U1			-48	-48	2-18" B @ 42.7# Cover PL 21"x⅜"	36.8			
U1-U3	-651	-269	-63	-1252	2-18" B @ 58# Cover PL 21"x⅜" 17½"x7/16" (31)	45.8			rz=6.8
U2-U3	-981	-401	-63	-1846	2-18" B @ (58#) Cover PL 21"x⅜" 2 PL(18"x7/16") 2 PL 17½"x7/16" (31)	70.5			rz=6.5
U3-U4	-791	-326	-63	-1506	2-18" B @ (58#) Cover PL 21"x⅜" 2 PL(15"x⅜") (31)	57.0			rz=6.9
U4-U5			-48	-48	2-18" B @ 42.7# Cover PL 21"x⅜" 17½"x7/16"	36.8			
L0-L2	+348	+144		+657	2-18" B @ 42.7# (31)	25.0	20.5		
L2-L4	+859	+355	+13	+1620	2-18" B @ 58# 2 PL 18"x⅜" (31)	58.7	50.4		
L4-L6	+951	+393	+13	+1793	2-18" B @ 58# 4 PL 18"x3/8" 7/16" (31)	64.3	55.0		
L2-L3	+462	+192		+873	2-18" B @ 58# (31)	34.0	27.0		
L0-U1	-536	-242		-1038	2-18" B @ 58# 2 PL 15"x⅜" (31)	50.8			rz=5.7
U1-L2	+455	+220		+901	2-18" B @ 42.7# 2 PL 15"x⅜" (31)	36.2	31.1		
L2-U3	-294	-174		-642	2-18" B @ 45.8# (31)	26.8			rz=6.5
U3-L4	+175	+139		+453	2-15" B @ 33.9# (31)	19.8	16.6		
L4-U5	+43	+ 88 / - 89		+ 317 / - 220	2-15" B @ 33.9#	19.8	16.6		
U5-L6	-219	-154		-527	2-18" B @ 51.9#	30.4			rz=6.4
L6-U7	+424	+209		+845	2-18" B @ 58# (31)	34.0	27.0		
U7-L8	-626	-282		-1210	2-18" B @ 58# 2 PL 18"x⅞" (31)	52.0			rz=5.9
L0-U6	-49	-84	-37	-254	2-15" B @ 33.9# L0-U6: L	19.8			rz=5.6
L2-U5	-101	-84	-9	-278	2-15" B @ 33.9# L2-U5: L	19.8			
R0 Gross	448	205	37						
R0 Net	448	205	27						

Notes:
The stress in the column marked "Design Stress" equals for each member, the largest of the following two values: ½(D+L+I); D+2(L+I)+W; See Specifications.
Material listed under "Make-up of Section" and marked (31) to be of silicon steel. Main Truss gusset plates to be of carbon steel unless otherwise designated on the plans. All other material including rivets to be of carbon steel.







Max. F.B. Reaction
26' Panel
D.L. = 88.6
L.L. = 65.5
Imp = 21.7
D+L = 175.8
D+L = 263.

Note:-
See Sheet No. 14 for additional notes.
For Sections A-A, B-B etc see Sheet No. 15
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Charles H. Spofford

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.
HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS
BOURNE BRIDGE
TRUSSES AND BRACING - SPAN 6
SCALE EXCEPT AS SHOWN
2 1 0 2 4 6 8 FT.
APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933
SUPERSTRUCTURE CONTRACT PLANS SHEET No. 13 OF (17)

Figure 12

Revised Sections shown in Ink 2/12/34

$U_1 U_3$ 2-18"[B 51.9 / 2-Pl. 21"×7/16" / 2-Pls 17½"×5/8" } Gross Area 640.6 in²

$U_3 U_5$ 2-18"[B 51.9# / 1 Pl 21"×2/16" / 4 Pls 17½"×5/8" } Gross Area 86.0

U_5-U_7 2-18"[B 51.9# / 1-Pl. 21"×9/16" / 2-Pls. 17½"×9/16" } Gr. A. 31.9 in²

PLAN OF TOP CHORD (Near Truss)

Typical Diaphragm at all floor beams

Typical Diaphragm at all panel points

ELEVATION OF TRUSS

Total thickness of bearing 2⅜" on each side.

Total thickness of bearing 2⅜" on each side

PLAN OF BOTTOM CHORD (Far Truss)

Note:
In the truss diagrams the vertical dimensions shown are computed to the center of the channels of the top chord members and not to the neutral axes or working lines which are to be used in the detailing in accordance with the specifications.
(The vertical dimensions are such as to keep the top of the cover plates of the top chord at a definite distance from the crown of the roadway)

Member	Stresses in Kips: Dead	Live + Impact	Wind	Design Stress	Make-up of Section	Area: Gross	Net	Assembly	Radius of Gyration
U_0-U_1			-56	-56	2-18" B @ 42.7# Cover PL 21"×⅜" 17½" 9"	36.8			
U_1-U_3	-885	-337	-74	-1633	2-18" B @ (58#) Cover PL 21"×⅜" 2 PL (18"×⅞")	63.8			r₂=6.5
U_3-U_5	-1205	-461	-74	-2220	2-18" B @ (58#) Cover PL 21"×⅜" 4 PL (18"×⅞")	86.3			r₂=6.2
U_5-U_7	-863	-329	-74	-1595	2-18" B @ (58#) Cover PL 21"×⅜" 2 PL (18"×⅞")	61.5			r₂=6.5
U_7-U_8			-56	-56	2-18" B @ 42.7# Cover PL 21"×⅜" 17½" 9"	36.8			
L_0-L_2	+500	+191		+922	2-18" B @ 58#	34.0	29.8		
L_2-L_4	+1120	+428	+16	+2064	2-18" B @ 58# 4 PL 18"×⅜"	79.0	68.7		
L_4-L_6	+1105	+425	+16	+2040	2-18" B @ 58# 2 PL 18"×⅜" 2 PL 18"×⅜"	76.8	66.7		
L_6-L_8	+478	+182		+880	2-18" B @ 58#	34.0	29.8		
L_0-U_1	-722	-299		-1362	2-18" B @ 58# 2 PL 18"×½" 2 PL 18"×⅜"	67.7			r₂=5.8
U_1-L_2	+518	+235		+1004	2-18" B @ 45.8# 2 PL 15"×⅜"	38.0	32.0		
L_2-U_3	-328	-186		-700	2-18" B @ 58#	34.0			r₂=6.3
U_3-L_4	+115	+130 −91		+415 −123	2-15" B @ 33.9#	19.8	17.4		r₂=5.6
L_4-U_5	+141	+191 −141		+451 −84	2-15" B @ 33.9#	19.8	17.4		r₂=5.6
U_5-L_6	-329	-185		-698	2-18" B @ 58#	34.0			r₂=6.3
L_6-U_7	+540	+236		+1035	2-18" B @ 51.9# 2 PL 15"×⅜"	41.6	35.7		
U_7-L_8	-682	-282		-1286	2-18" B @ 58# 2 PL 18"×⅜" 2 PL 18"×9/16"	63.2			r₂=5.8
U_0-L_1, L_1-L_2	-69	-112	-43	-336	2-15" B @ 33.9#	19.8			r₂=5.6
U_6-L_7	-137	-112	-10	-371	2-15" B @ 33.9# [illegible]	19.8			r₂=5.6
Rg Gross	470	227	41		2-15" B @ 33.9 U_1-L_1, U_3-L_3, U_5-L_5, U_7-L_7				
Rg Gross	470	227	43						

Notes:
The stress in the column marked "Design Stress" equals for each member, the largest of the following two values: ½(D+L+I); D+2(L+I)+W. See specifications.
Material listed under "Make-up of Section" and marked (51) to be of silicon steel. Main truss gusset plates to be of carbon steel unless otherwise designated on the plans. All other material including rivets to be of carbon steel.

ELEVATION

8 Panels @ 30'-0" = 240'-0"

Elevation 162.0

HALF PLAN OF TOP LATERAL BRACING

(Symmetrical about ℄ except as noted)

HALF PLAN OF BOTTOM LATERAL BRACING

Max F.B. Reaction

SCALE

END PANELS U_0-L_0, U_8-L_8

INTERMEDIATE PANELS U_1-L_2, U_4-L_4, U_6-L_6

SWAY BRACING

Note: See Sheet No. 14 for additional notes.

Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.

30' Panel
D.L. = 100.7
L.L. = 66.2
Imp = 21.5
D+L = 188.4
D+2L = 276.1

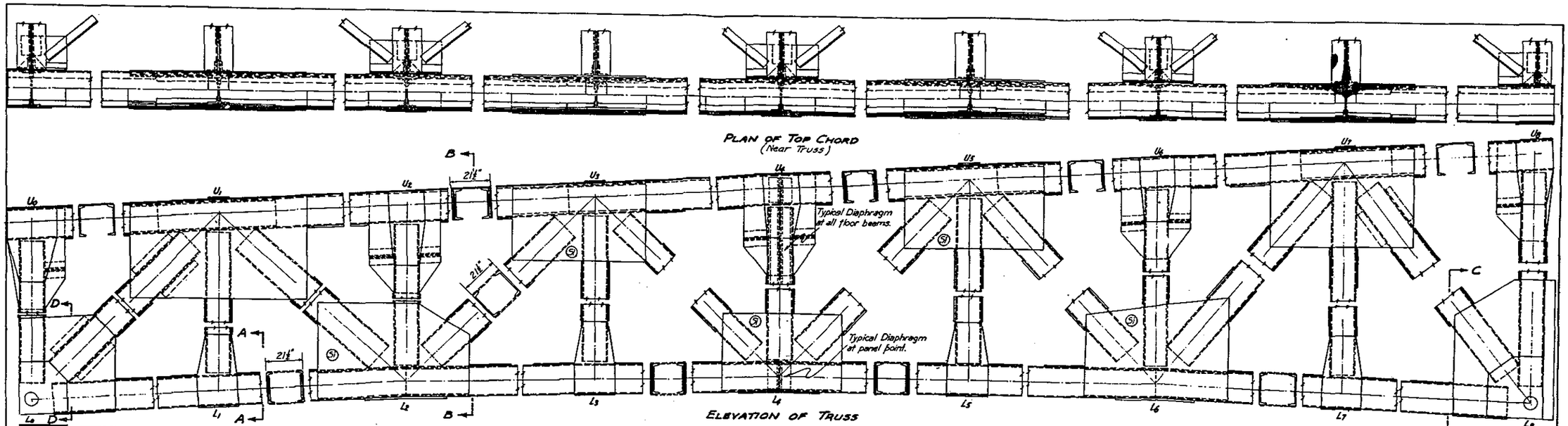
WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.
HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS
BOURNE BRIDGE
TRUSSES AND BRACING-SPAN 7
SCALE EXCEPT AS SHOWN

APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933

FAY, SPOFFORD & THORNDIKE, ENGINEERS

SUPERSTRUCTURE CONTRACT PLANS SHEET NO. 12 OF 17 SHEETS

Figure 13

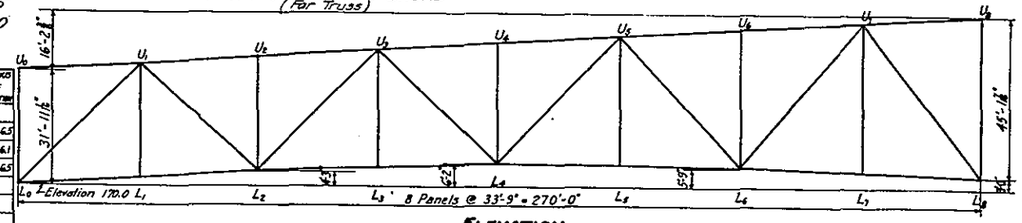


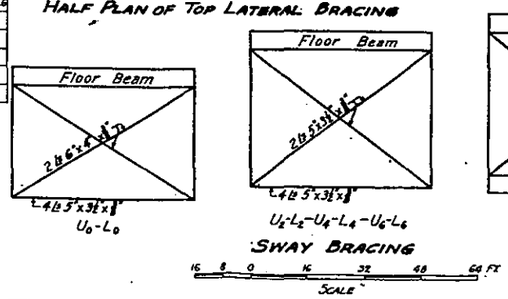
4 Pls 17½ × 11/16"

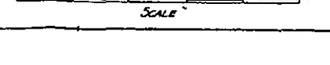
Member	Stress in Kips Dead	Live + Impact	Wind	Design Stress	Make-up of Section (17½ × ½)	Area Gross	Area Net	Assembly	Radius of Gyration
U_0-U_1			-82	-82	Cover R 21" × ⅞" 2-⊔s-18"@42.7"	36.76		▯	
U_1-U_2	-1000	-363	-117	-1543	Cover R 21" × ⅞" 4R(18" × ⅞") 2-⊔s-18"@58" (51) 51.9"	77.3		▯	r_x=6.5
U_2-U_3	-1245	-454	-117	-2270	Cover R 21" × ⅞" 2R(18" × ⅞") 2R18"×⅞" 2-⊔s-18"@58" (51) 51.9"	93.01		▯	r_x=6.1
U_3-U_4	-828	-302	-117	-1549	Cover R 21" × ⅞" 2R(18" × ⅞") 2-⊔s-18"@58" (51) 51.9"	61.51		▯	r_x=6.5
U_4-U_5			-82	-82	Cover R 21" × ⅞" 2-⊔s-18"@42.7" 17½ × 9/16	36.76		▯	
L_0-L_2	+579	+212		+1054	45.8 2-⊔s-18"@51.9" 2R(21" × ⅞") 18 × 9/16 (51)	41.61	35.21	▯	
L_2-L_4	+1200	+439	+20	+2186	2-⊔s-18"@58" 4R 18" × ⅞" (51)	83.46	68.5	▯	
L_4-L_6	+1090	+397	+20	+1982	2-⊔s-18"@58" 4R 18" × ⅞" (51)	74.46	60.98	▯	
L_6-L_8	+440	+161		+802	2-⊔s-18"@51.9" (51)	30.36	24.26	▯	
L_0-U_1	-825	-308		-1511	2-⊔s-18"@58" 4R 18" × ⅞" (51)	83.46		▯	r_x=5.7
U_1-L_2	+564	+245		+1078	2-⊔s-18"@51.9" 2R 15" × ⅞" (51)	41.61	35.21	▯	
L_2-U_3	-296	-163		-622	2-⊔s-18"@58" (51)	33.96		▯	r_x=6.3
U_3-L_4	+ 55	+114 -93		+340 -332	2-⊔s-15"@33.9" 45# changed by A.B.Co. for erection stresses (51)	19.8	15.7	▯	r_x=5.6
L_4-U_5	+218	+159		+ 536	2-⊔s-18"@58" 58# (51)	26.76	22.26	▯	
U_5-L_6	-398	-198		-795	2-⊔s-18"@51.9" 2R 18" × ⅞" (51)	43.86		▯	r_x=6.1
L_6-U_7	+600	+254		+1138	2-⊔s-18"@58" 2R 15" × ⅞" (51)	45.21	38.41	▯	
U_7-L_8	-717	-267		-1312	2-⊔s-18"@58" 2R 18" × ⅞" 2R 18" × ⅞" (51)	81.21		▯	r_x=5.7
L_0-U_0	- 78	- 94	- 67	-323	2-⊔s-15"@33.9" L_0-U_0 (51)	19.8		▯	r_x=5.6
L_6-U_6	-156	- 94	- 14	-358	2-⊔s-15"@33.9" L_6-U_6 L_6-U_8 (51)	19.8		▯	r_x=5.6
					2-⊔s-15"@33.9" L_1-U_1 L_2-U_2 L_5-U_5 L_7-U_7				
R_o Gross	536	247	48						
R_o Gross	538	247	67						

* Chan

Notes:
The stress in the column marked "Design Stress" equals for each member, the largest of the following two values: ⅘(D+L+I); D+2(L+I)+W. See specifications.
Material listed under "Make-up of Section" and marked (51) to be of silicon steel. Main Truss gusset plates to be of carbon steel unless otherwise designated on the plans. All other material including rivets to be of carbon steel.







Note:
Thickness, number and size of gusset plates at all main truss joints to be determined by contractor to carry flexure, direct stress and shear.
Latticing:- For members carrying compression only or compression and flexure, latticing is to be proportioned in accordance with the American Association of State Highway Officials Specifications.
For members, the design of which is controlled by tension but which also carry compression, latticing is to be proportioned to carry shear equal to 2½ per cent of the total compression divided equally between the two flanges; double latticing to be used with bars not less than 2½ inches × 7/16 inches.
For members carrying tension only, double latticing to be used with 2½ inches × ⅜ inch bars.

FAY, SPOFFORD & THORNDIKE, ENGINEERS
By Edmund M. Spofford

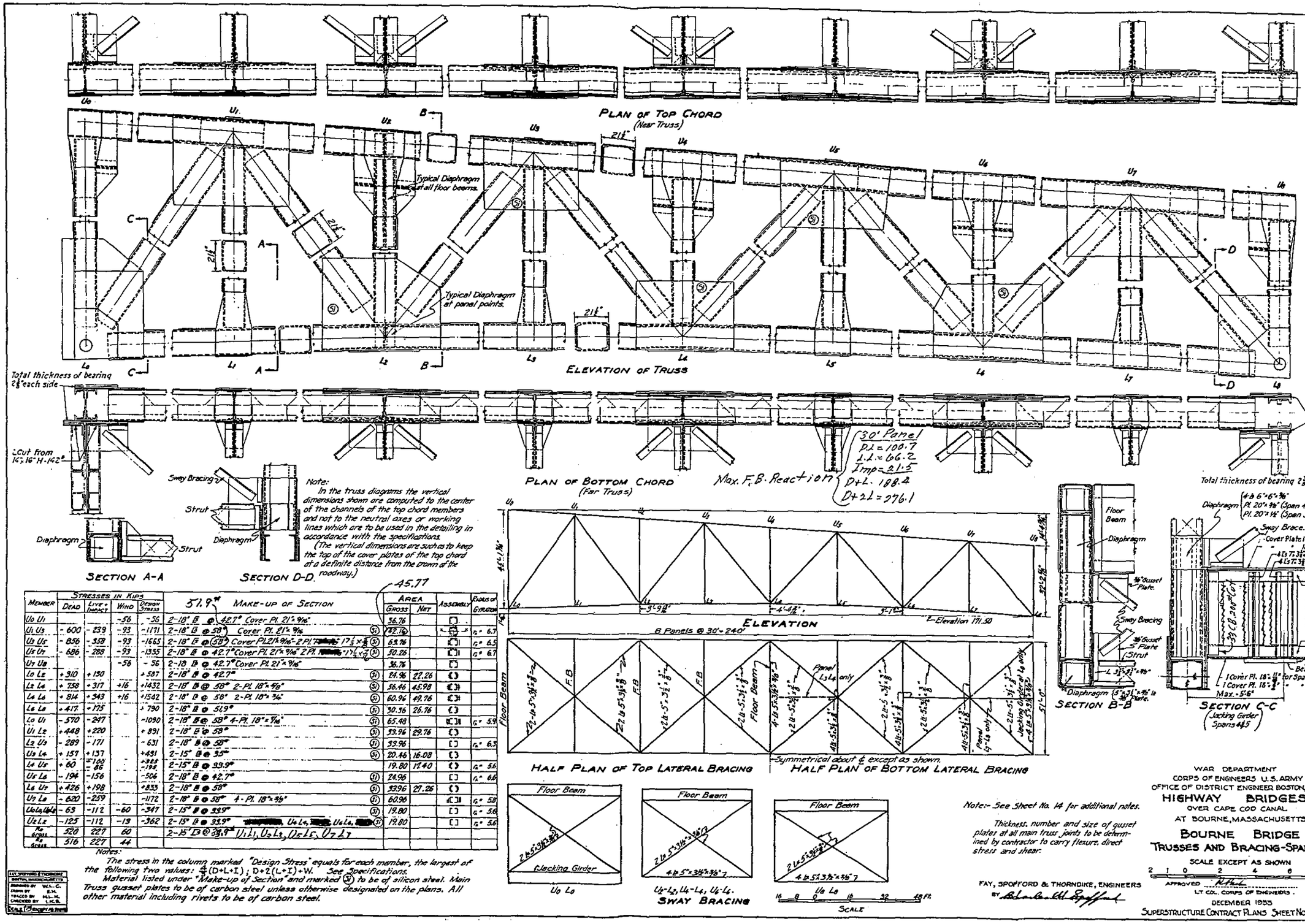
Note:
In the truss diagrams the vertical dimensions shown are computed to the center of the channels of the top chord members and not to the neutral axes or working lines which are to be used in the detailing in accordance with the specifications.
(The vertical dimensions are such as to keep the top of the cover plates of the top chord at a definite distance from the crown of the roadway.)

Notes:-
For General Plan and Elevations - See sheets Nos. 2 and 3.
For Deck Sections and Deck Details - See Sheets Nos. 4 and 5.
For Truss Bearings - See Sheet No. 17.
For Sections A-A, B-B, C-C, D-D. See Sheet No. 15.
Where consistent with shipping requirements, two or more panel lengths of chord members shall be fabricated as one member.
Joints in compression members shall be faced to bear.
Open holes for field rivets to be 9/16" ϕ unless otherwise noted. 1¼" ϕ for all Truss Joints.
Compression edges of main gusset plates to be stayed against buckling by angles or plates where unsupported lengths exceed 12 times the plate thickness wherever maximum allowable stress occurs at edge. For stresses less than maximum, unstayed lengths may be increased proportionally.
All rivets ½ ϕ.
All elevations are referred to a datum 100 feet below Mean Sea Level.

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.
HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS
BOURNE BRIDGE
TRUSSES AND BRACING - SPAN 5
SCALE EXCEPT AS SHOWN
APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933
SUPERSTRUCTURE CONTRACT PLANS SHEET NO. 14 OF (17) PLANS

FAY, SPOFFORD & THORNDIKE
BOSTON, MASSACHUSETTS
DESIGNED BY W.L.C.
DRAWN BY P.M.
TRACED BY W.K.P.
CHECKED BY F.K.S.
SCALE 1:5 EXCEPT AS SHOWN

Figure 14



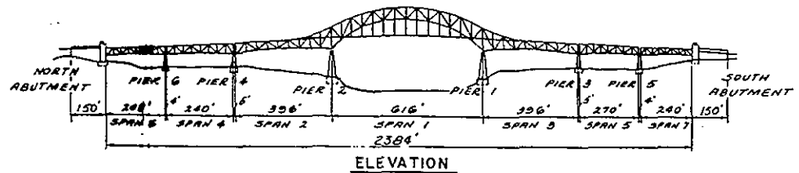
Member	Stresses in Kips: Dead	Live + Impact	Wind	Design Stress	51.9# Make-up of Section	Area: Gross	Area: Net	Assembly	Radius of Gyration
U_0U_1			-56	-56	2-18" B @ 42.7° Cover Pl. 21"x 9/16"	36.76			
U_1U_3	-600	-239	-93	-1171	2-18" G @ 50° Cover Pl. 21"x 9/16" (S)	82.16			r_x = 6.7
U_3U_5	-856	-358	-93	-1665	2-18" G @ 58° Cover Pl. 21"x 9/16" 2 Pl. [illegible] (S)	69.76			r_x = 6.5
U_5U_7	-686	-288	-93	-1355	2-18" B @ 42.7° Cover Pl. 21"x 9/16" 2 Pl. [illegible] (S)	50.26			r_x = 6.7
U_7U_8			-56	-56	2-18" B @ 42.7° Cover Pl. 21"x 9/16"	36.76			
L_0L_2	+310	+150		+587	2-18" B @ 42.7° (S)	84.96	77.26		
L_2L_4	+758	+317	+16	+1432	2-18" B @ 58° 2-Pl. 18"x 7/8" (S)	96.46	45.98		
L_4L_6	+814	+343	+16	+1542	2-18" B @ 58° 2-Pl. 18"x 3/4" (S)	60.96	49.76		
L_6L_8	+417	+175		+790	2-18" B @ 51.9° (S)	50.36	26.76		
L_0U_1	-570	-247		-1090	2-18" B @ 58° 4-Pl. 18"x 9/16" (S)	65.48			r_x = 5.9
U_1L_2	+448	+220		+891	2-18" B @ 58° (S)	93.96	89.76		
L_2U_3	-289	-171		-631	2-18" B @ 58° (S)	93.96			r_x = 6.3
U_3L_4	+157	+137		+431	2-15" B @ 35° (S)	20.46	16.08		
L_4U_5	+60	±100 − 86		+223 −196	2-15" B @ 39.9°	19.80	17.40		r_x = 5.6
U_5L_6	-194	-156		-506	2-18" B @ 42.7° (S)	24.96			r_x = 6.6
L_6U_7	+426	+198		+833	2-18" B @ 58° (S)	93.96	89.26		
U_7L_8	-620	-259		-1172	2-18" B @ 58° 4-Pl. 18"x 3/8" (S)	60.96			r_x = 5.8
U_0L_0 & U_8L_8	-63	-112	-60	-347	2-15" B @ 39.9° (S)	19.80			r_x = 5.6
U_8L_8	-125	-112	-19	-362	2-15" B @ 39.9° [illegible] U_6L_6, [illegible] U_8L_8, [illegible] (S)	19.80			r_x = 5.6
For Rivets	520	227	60		2-15" B @ 39.9# U_1L_1, U_2L_2, U_5L_5, U_7L_7				
For Bolts	516	227	44						

Notes:
The stress in the column marked "Design Stress" equals for each member, the largest of the following two values: $\frac{4}{3}(D+L+I)$; $D+2(L+I)+W$. See Specifications.
Material listed under "Make-up of Section" and marked (S) to be of silicon steel. Main Truss gusset plates to be of carbon steel unless otherwise designated on the plans. All other material including rivets to be of carbon steel.

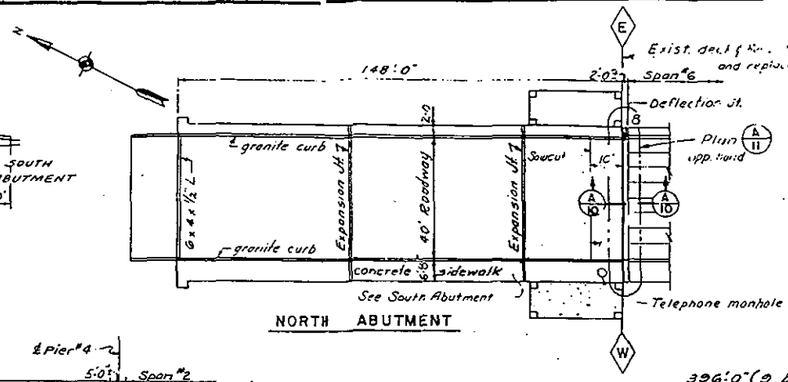
FAY, SPOFFORD & THORNDIKE ENGINEERS BOSTON, MASSACHUSETTS
DRAWN BY W.L.C.
TRACED BY E.N.
CHECKED BY H.L.H. L.H.S.

Figure 15

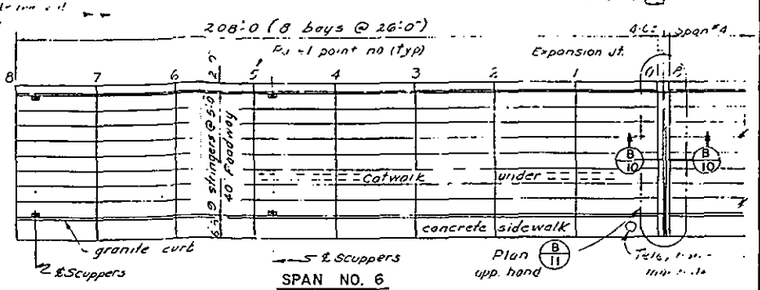
CORPS OF ENGINEERS — U. S. ARMY



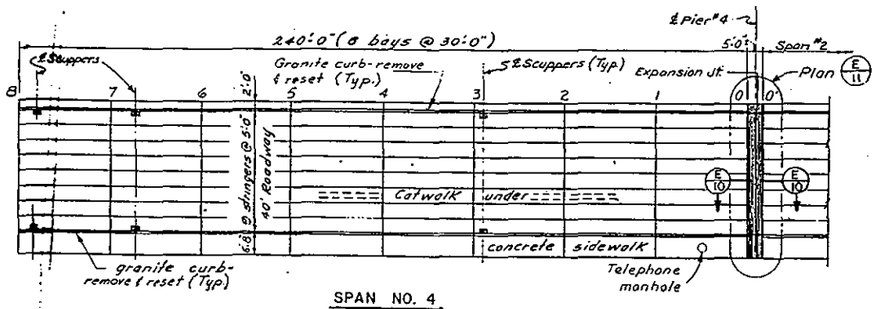
ELEVATION
(LOOKING EAST)
N.T.S.



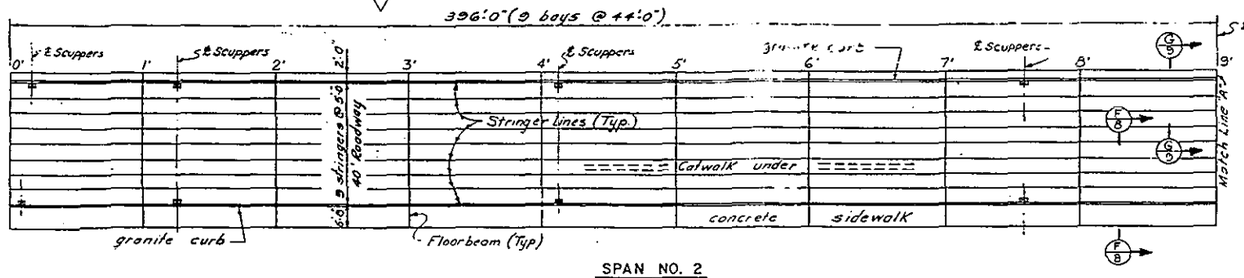
NORTH ABUTMENT



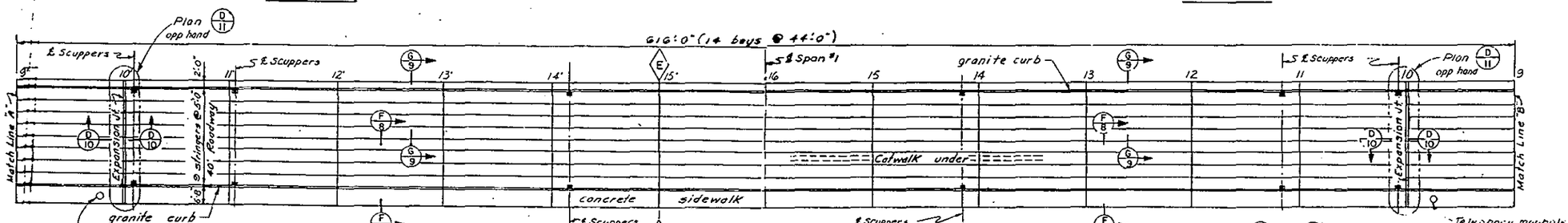
SPAN NO. 6



SPAN NO. 4

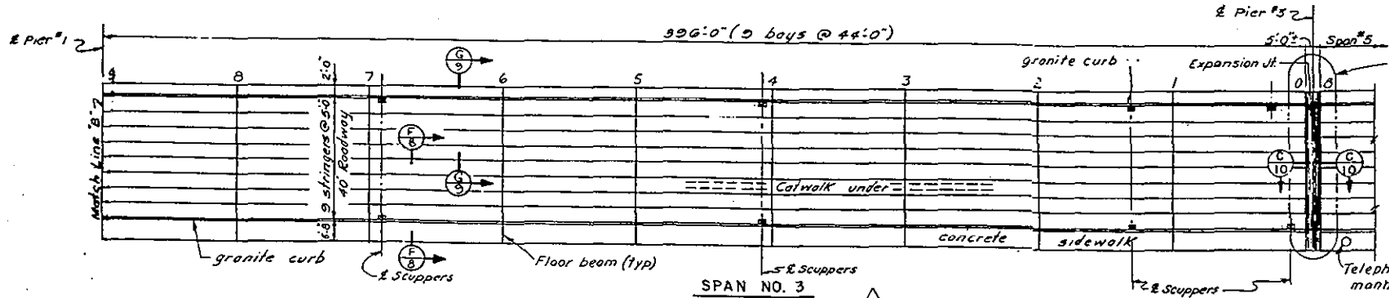


SPAN NO. 2

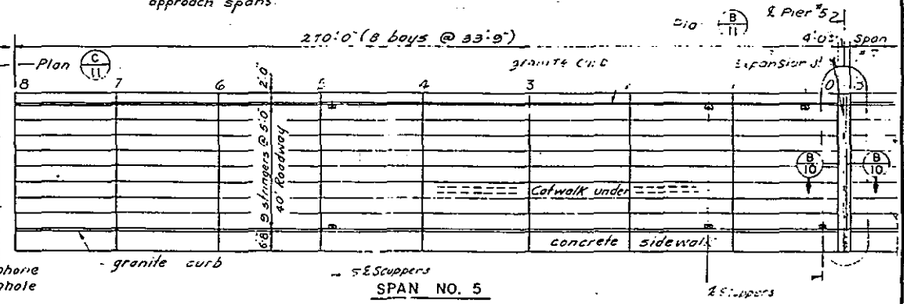


SPAN NO. 1

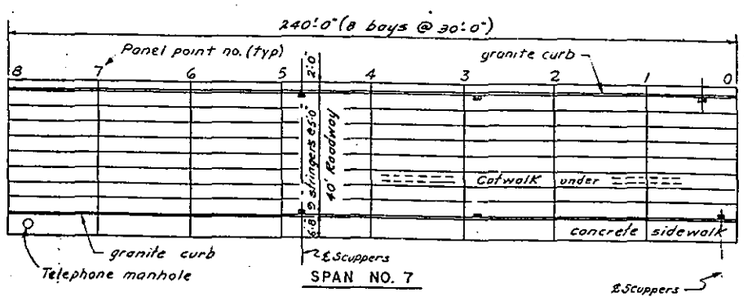
Note: Sections (F/8) and (G/9) are Typical for all main spans and approach spans.



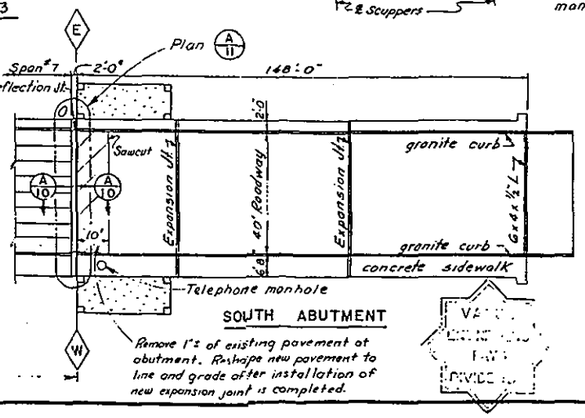
SPAN NO. 3



SPAN NO. 5



SPAN NO. 7



SOUTH ABUTMENT

Exist. deck & fence to be removed & replaced

NOTES:

1. Existing granite curbs are to be removed and reset
2. Existing telephone manholes are to be removed and reset in new concrete sidewalk. For additional reinforcement detail see Sh. 8.
3. Existing scuppers are to be reworked and reused. Scuppers are to be located over existing steel drain pipes. For details see Sh. 9.
4. New electrical handholes are not shown on this sheet. For location see Electrical Drawing, Sh. 14. For additional reinforcement detail see Sh. 8.
5. For demolition work required, see Sh 7.

SAFETY PAYS

GRAPHIC SCALE
1"=20' 20' 0 20' 40'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
WHR	RDP	WHR

SUBMITTED
Chief, Struct. Section
APPROVAL RECOMMENDED
Chief, Design Branch
REVIEWED
Project Manager
APPROVED
Chief, Eng. Reports Div. Br.

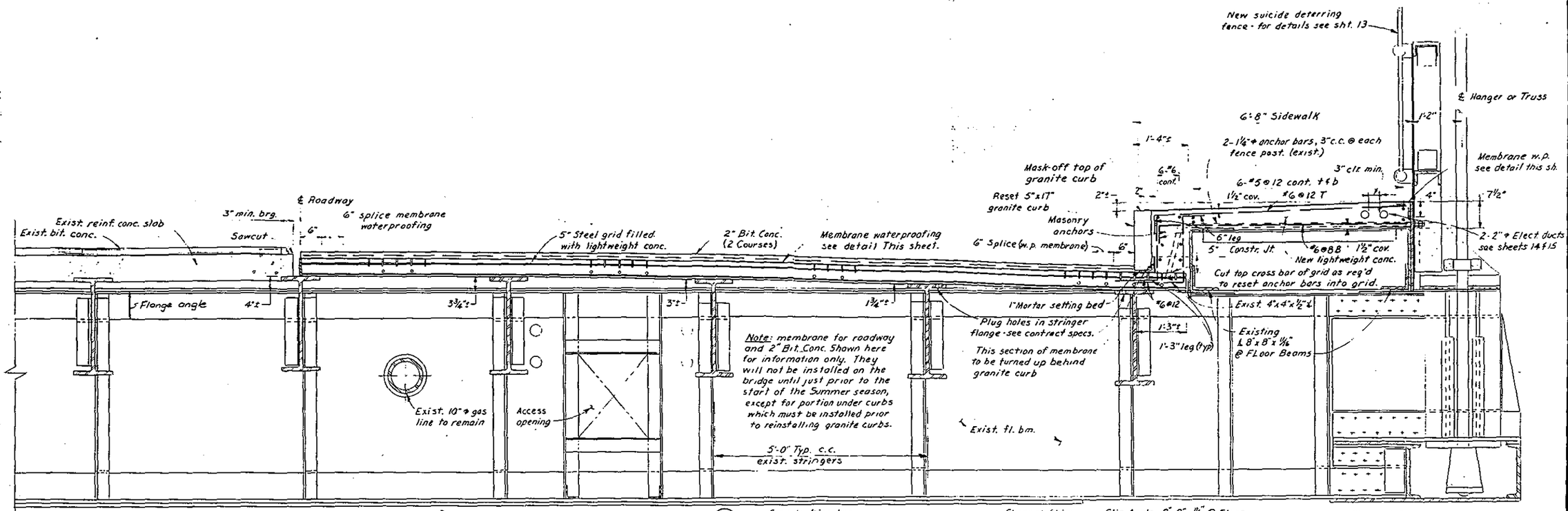
MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
DECK PLAN

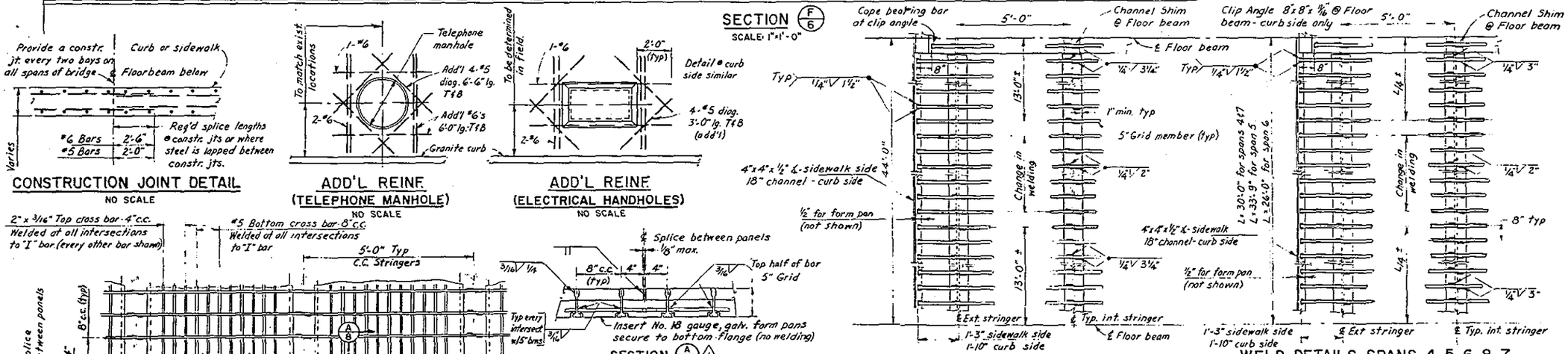
BOURNE MASSACHUSETTS
DATE APRIL 1979

SCALE: 1" = 20' | SPEC. NO. DACW33-79-B-0012
DRAWING NUMBER CAP-51
SHEET 6

Figure 16

CORPS OF ENGINEERS — U. S. ARMY





SECTION (F/6)
SCALE: 1"=1'-0"

CONSTRUCTION JOINT DETAIL
NO SCALE

ADD'L REINF. (TELEPHONE MANHOLE)
NO SCALE

ADD'L REINF. (ELECTRICAL HANDHOLES)
NO SCALE

PLAN
SCALE: 3/4"=1'-0"

SECTION (A/8) ⚠
SCALE: 1'-1/2"=1'-0"

SECTION (B/8) ⚠
SCALE: 3"=1'-0"

WELD DETAILS-SPANS 1, 2 & 3
SCALE: 1/2"=1'-0"

WELD DETAILS-SPANS 4, 5, 6 & 7
SCALE: 1/2"=1'-0"

WELD DETAIL AT SCUPPERS
SCALE: 1"=1'-0"

3/8"x 5" Plates
(typ)
5/16
5" grid
Scupper (grating not shown see sht. 9 for details)

STEEL BEAM BRIDGE FLOORING DETAILS

VALUE ENGINEERING PAYS DIVIDENDS

SAFETY PAYS

GRAPHIC SCALES
1/2" = 1'-0"
3/4" = 1'-0"
1" = 1'-0"
3" = 1'-0"

REVISION	DATE	DESCRIPTION	BY
⚠	5-8-79	STEEL BEAM BRIDGE FLOORING REVISED	

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY WRS | DR. BY R.D.P. | CK. BY

SUBMITTED: [illegible] M. Traynor
CHIEF, DESIGN SECTION

APPROVED RECOMMENDED: [illegible]
CHIEF, DESIGN BRANCH

APPROVED RECOMMENDED: [illegible]
CHIEF, PROJECT BRANCH

MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
NEW DECK DETAILS I

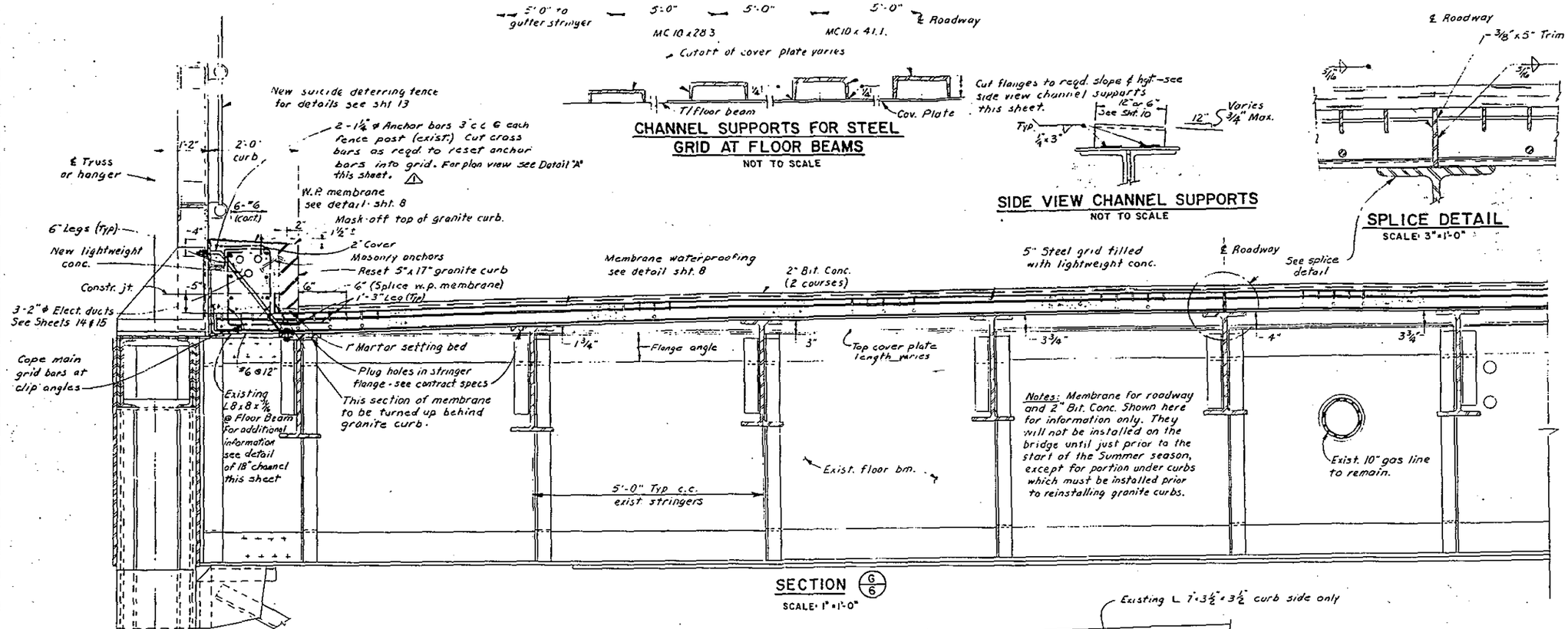
BOURNE MASSACHUSETTS

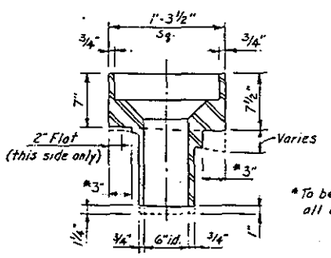
APPROVED: Jack B. Fryar, CHIEF, ENGINEERING DIVISION — DATE: APRIL 1979

SCALE AS SHOWN SPEC. NO DACW33-79-B-0012
DRAWING NUMBER CAP-51
SHEET 8

Figure 17

CORPS OF ENGINEERS — U. S. ARMY

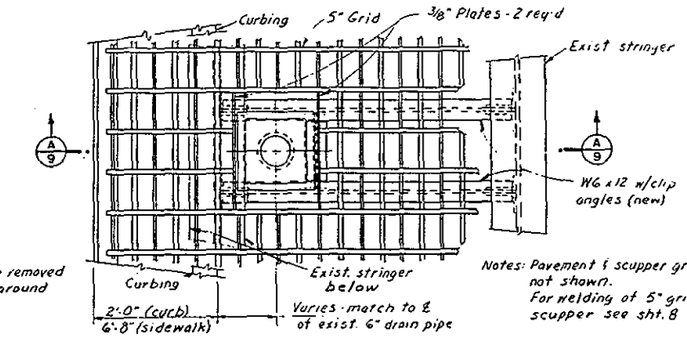




REVISED SCUPPER DETAIL
SCALE: 1-1/2"=1'-0"

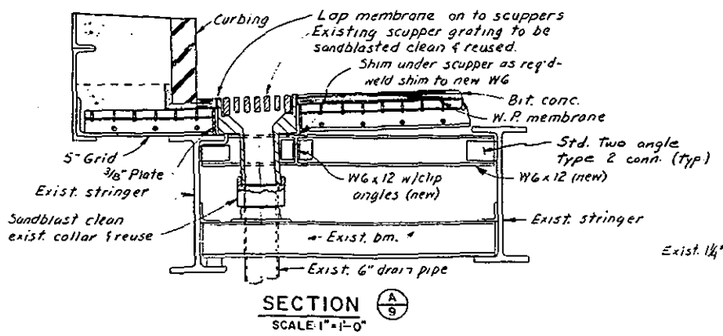
*To be removed all around

NOTE: Existing scuppers must be reworked as shown to fit new deck details

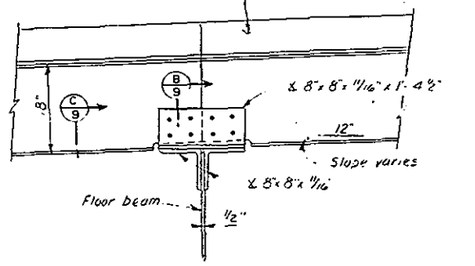


SCUPPER SUPPORT PLAN
SCALE: 1"=1'-0"

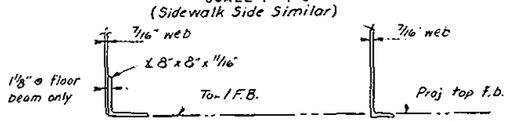
Notes: Pavement & scupper grating not shown.
For welding of 5" grid around scupper see sht. 8



SECTION (A/9)
SCALE: 1"=1'-0"

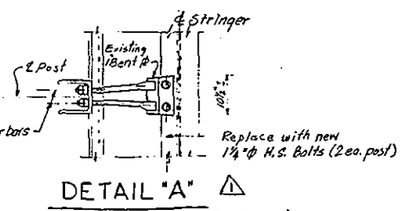


DETAIL OF 18" CHANNEL AT CURB SIDE CONNECTION TO FLOOR BEAM
SCALE: 1"=1'-0"
(Sidewalk Side Similar)

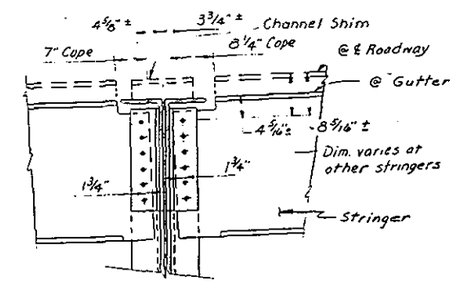


SECTION (B/9)
SCALE: 1"=1'-0"

SECTION (C/9)
SCALE: 1"=1'-0"



DETAIL "A" (1)
(Plan at Rail Post Anchor Bars - East Side)



STRINGER-FLOOR BEAM CONNECTION
SCALE: 1"=1'-0"

VALUE ENGINEERING PAYS DIVIDENDS

SAFETY PAYS

GRAPHIC SCALES
1"=1'-0" 1' 0 1' 2'
1 1/2"=1'-0" 12" 9" 6" 3" 0 6" 12"
3"=1'-0" 3" 0 3" 6" 12"

REVISION	DATE	DESCRIPTION	BY
1	5-11-79	ADDED DETAIL "A" (AM #3)	[illegible]

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY W.H.R. | DR. BY R.D.P. | CH. BY WHR

SUBMITTED: [illegible] CHIEF, STRUCT. SECTION

APPROVAL RECOMMENDED: [illegible] CHIEF, DESIGN BRANCH

REVIEWED: [illegible] CHIEF, PROJECT BRANCH

APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
NEW DECK DETAILS II

BOURNE MASSACHUSETTS

APPROVED: [illegible] CHIEF, ENGINEERING DIVISION DATE APR 11, 1979

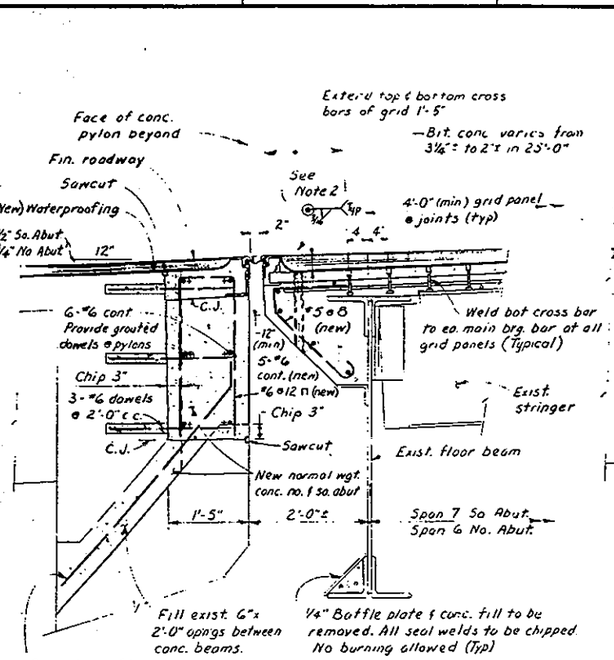
SCALE AS SHOWN SPEC. NO DACW33-79-B-0012

DRAWING NUMBER CAP-51

SHEET 9

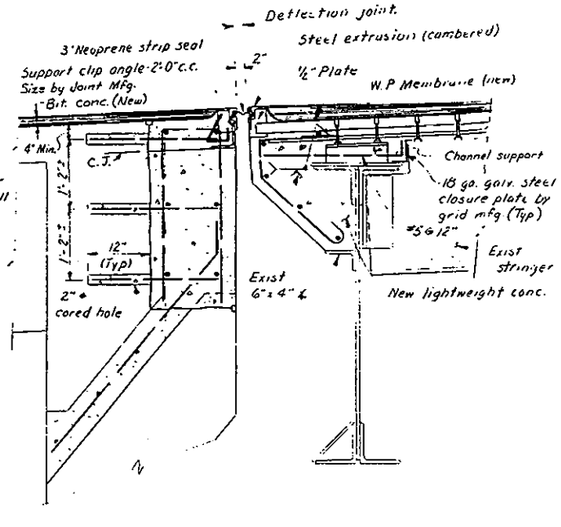
Figure 18

CORPS OF ENGINEERS — U. S. ARMY

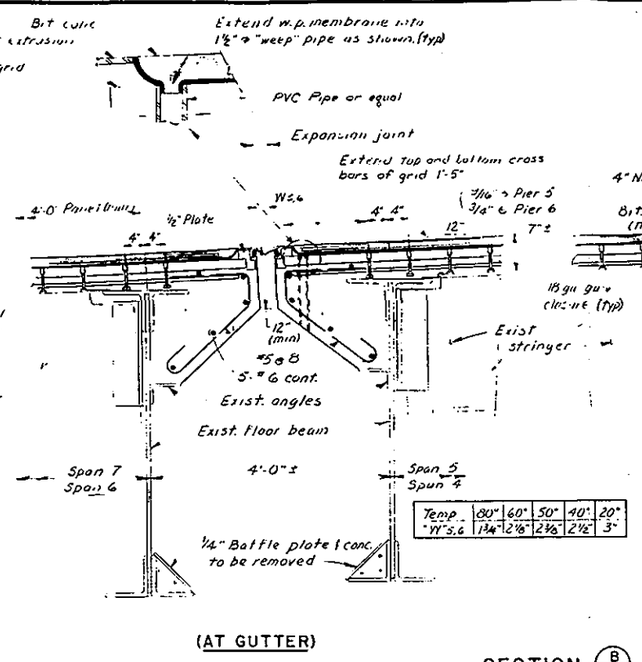


(AT GUTTER)

SECTION (A/6)



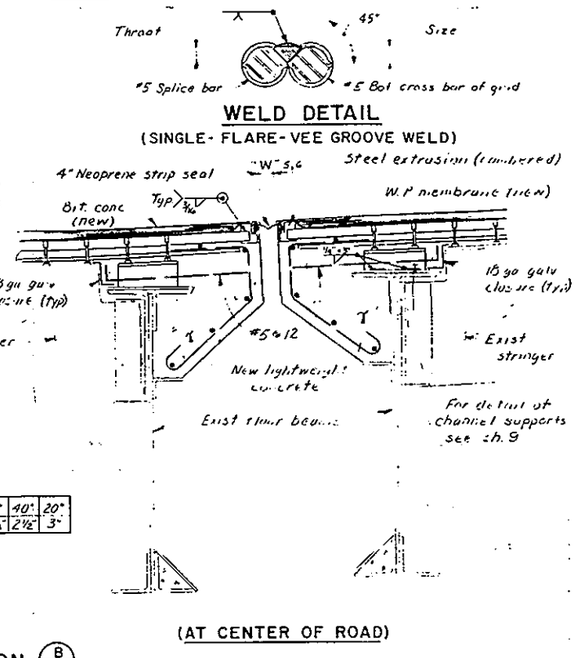
(AT CENTER OF ROAD)



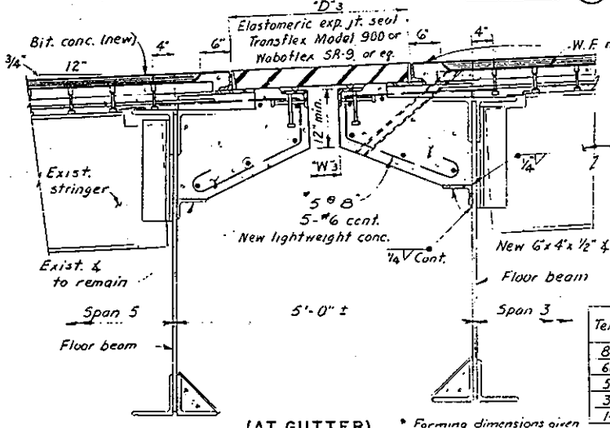
Temp.	80°	60°	50°	40°	20°
"W" S.6	1¾"	2⅛"	2⅜"	2½"	3"

(AT GUTTER)

SECTION (B/6)



(AT CENTER OF ROAD)

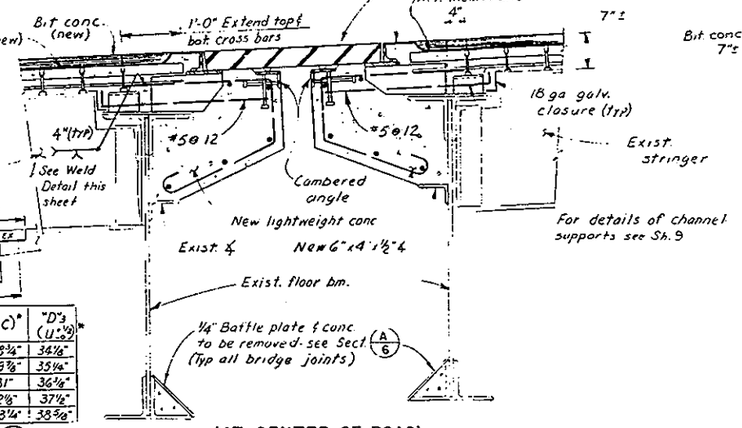


(AT GUTTER)

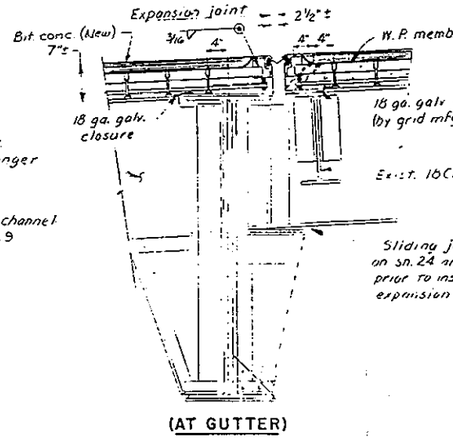
Temp.	"W3" (N)*	(C)*	"D" (U=0)*
86	4"	28¾"	34⅛"
68	5⅛"	29⅞"	35¼"
50	6¼"	31"	36⅛"
32	7⅜"	32⅛"	37⅛"
14	8½"	33¼"	38⅝"

* Forming dimensions given are for a Transflex Model 900 only. Mfg. shall provide forming dimen. for unit used.

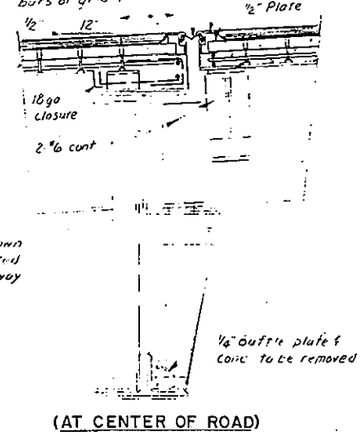
SECTION (C/6)



(AT CENTER OF ROAD)

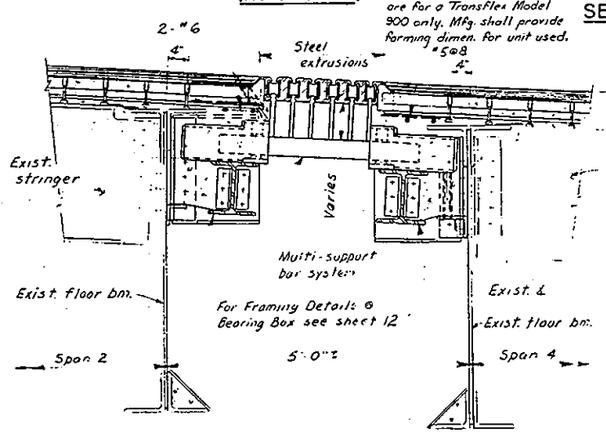


(AT GUTTER)



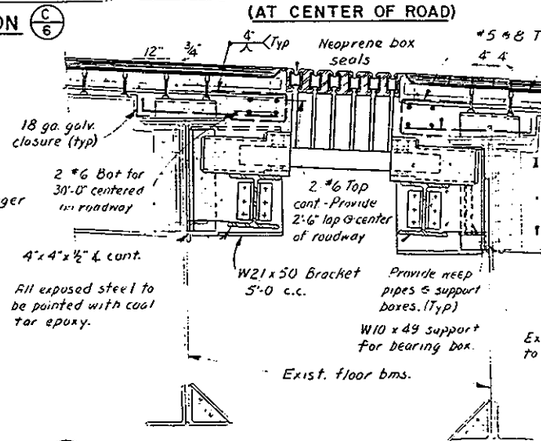
(AT CENTER OF ROAD)

SECTION (D/6)



(AT GUTTER)

SECTION (E/6)



(AT CENTER OF ROAD)

New A325-N.S. bolts @ stringer/bracket connection @ floor beam.

Note: Contractor to provide temporary support for stringer during bracket installation. Support method to be submitted for approval.

Notes:
1. All transverse reinf. to be lapped near center of roadway Provide 2'-6" splice.
2. Provide 1½" ø "weep pipes @ high side of all expansion joints - 2 ea. @ curb & sidewalk gutters.
3. Work this sheet with Shts 11&12.
4. For camber diagram see Sh. 12.

VALUE ENGINEERING PAYS DIVIDENDS

SAFETY PAYS

GRAPHIC SCALES
1" = 1'-0"
1' 0 1' 2'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK.
WHR	R.D.P	

SUBMITTED: Carmelo M. Tavolaro, CHIEF, STRUCT. SECTION
APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH
APPROVED: PROJECT MANAGER
APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

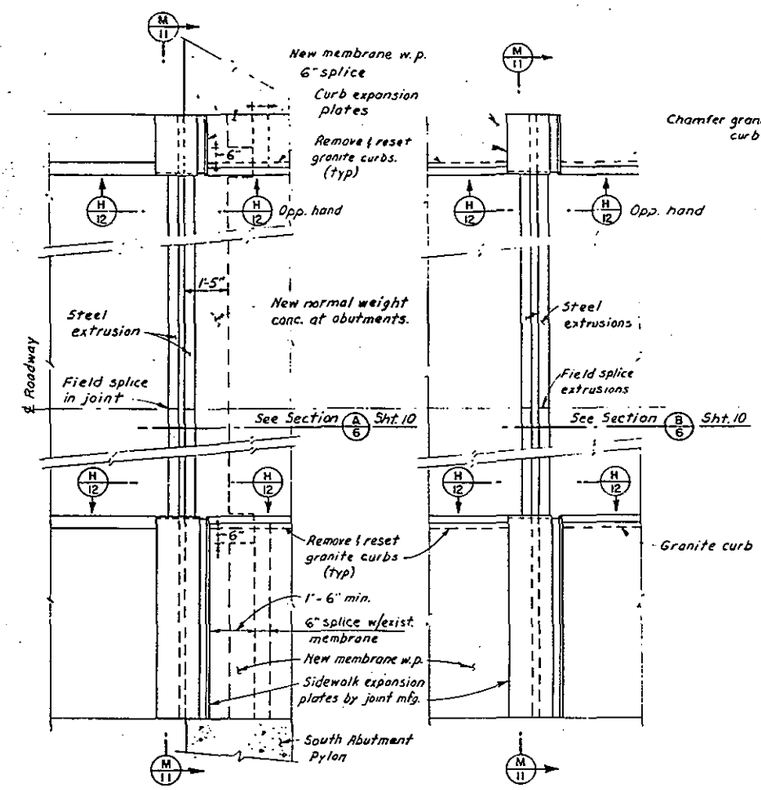
MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
EXPANSION DAM DETAILS I
BOURNE MASSACHUSETTS

APPROVED: Jesse B. Lugo, CHIEF, ENGINEERING DIVISION
DATE APRIL 1979

SCALE 1" = 1'-0" | SPEC NO DACW33-79-B-0012
DRAWING NUMBER CAP-51

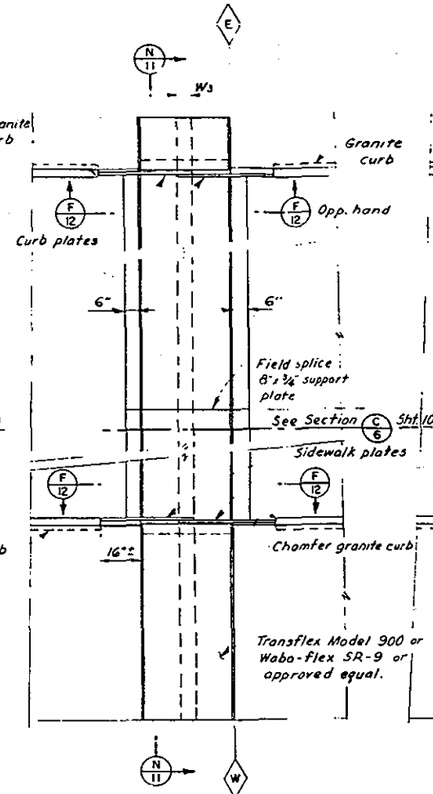
Figure 19

CORPS OF ENGINEERS — U. S. ARMY

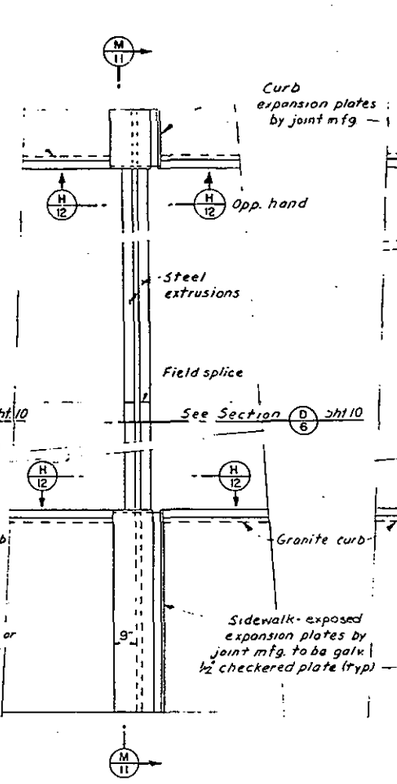


PLAN A/6
SCALE: 1/2"=1'-0"

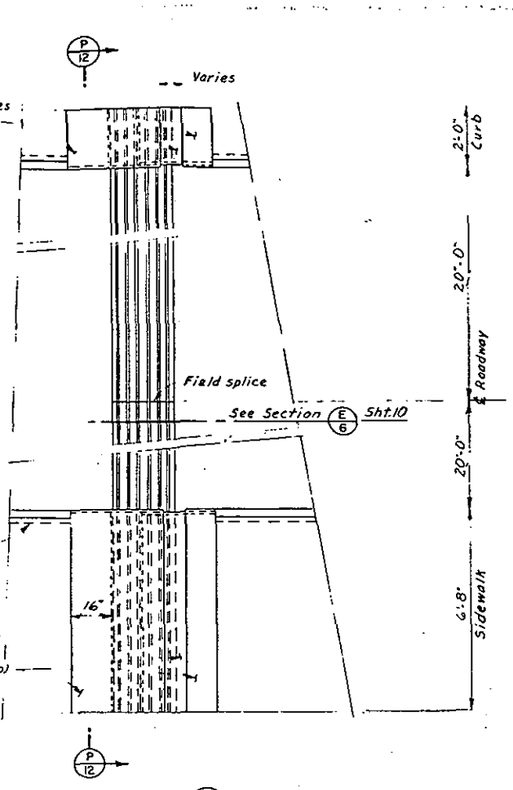
PLAN B/6
SCALE: 1/2"=1'-0"



PLAN C/6
SCALE: 1/2"=1'-0"

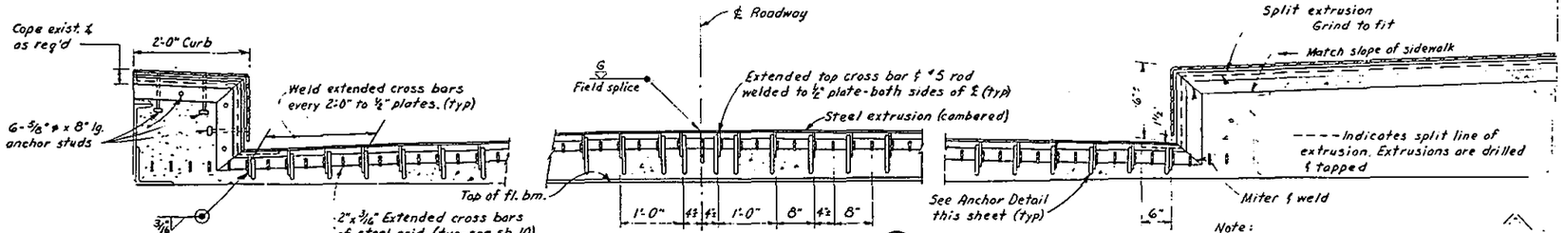


PLAN D/6
SCALE: 1/2"=1'-0"



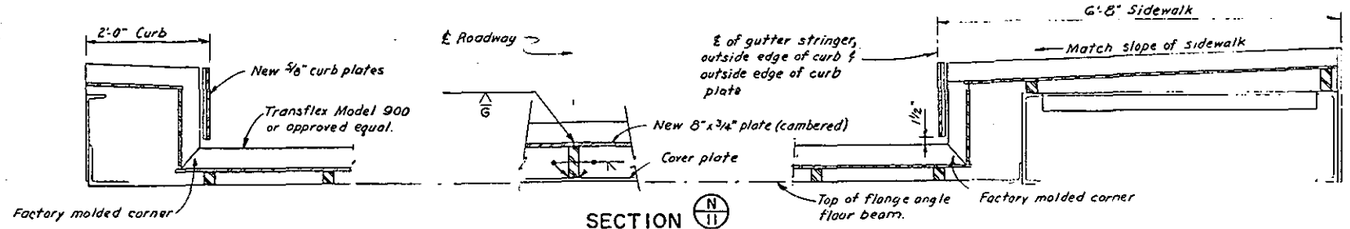
PLAN E/6
SCALE: 1/2"=1'-0"

Note:
At all curb and sidewalk deflection and expansion joints, the top bent floor plate shall be checkered and the bottom plate shall be smooth unless otherwise noted.

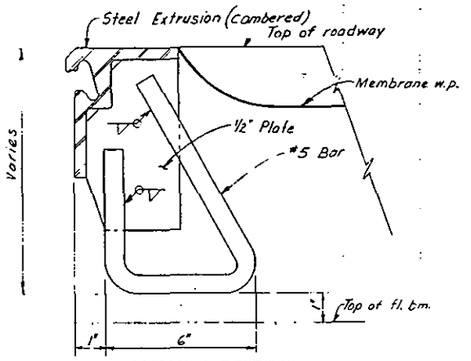


SECTION M/11
SCALE: 1"=1'-0"

Note:
For camber diagram see sh. 12



SECTION N/11
SCALE: 1"=1'-0"



ANCHOR DETAIL
SCALE: 6"=1'-0"

GRAPHIC SCALES
1/2"=1'-0" 1' 0 1' 2' 3' 4' 5'
1"=1'-0" 1' 0 1' 2'
6"=1'-0" 6" 0 6" 12"

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY WHR | DR. BY R.P. | CH. BY

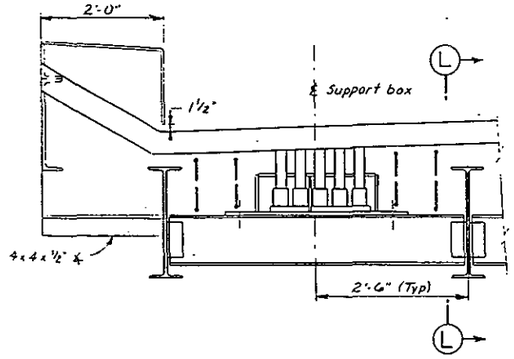
SUBMITTED: Stanley Milazzo, CHIEF, STRUCT. SECTION
APPROVED RECOMMENDED: Chief, DESIGN BRANCH
REVIEWED: PROJECT MANAGER
APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH
APPROVED: Joe B. Fuqua, CHIEF ENGINEERING DIVISION

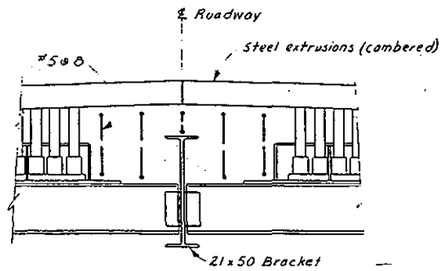
MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
EXPANSION DAM DETAILS II
BOURNE MASSACHUSETTS
DATE APRIL 1979

SCALE AS SHOWN | SPEC NO DACW33-79-B-0012
DRAWING NUMBER
CAP-51

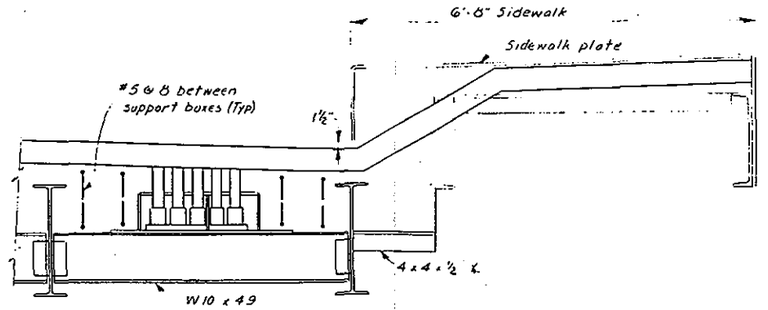
Figure 20

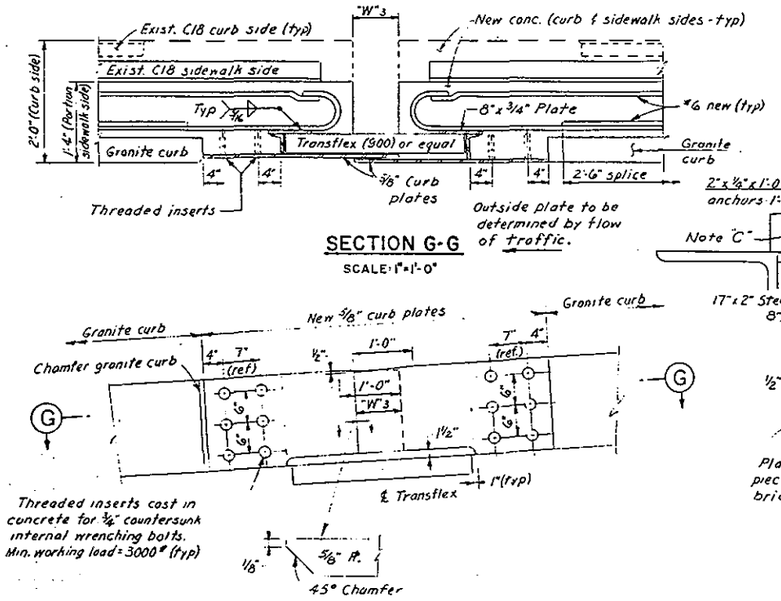
CORPS OF ENGINEERS A B C D E F G H U. S. ARMY



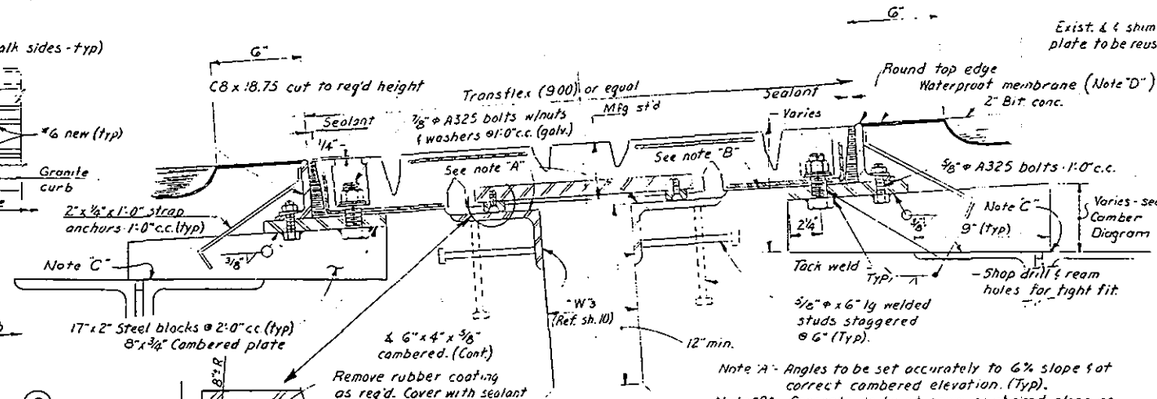


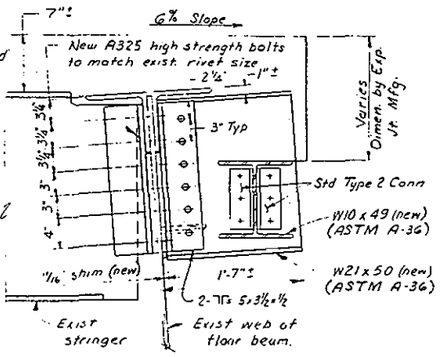
SECTION (P/11)
SCALE: 1"=1'-0"





SECTION G-G
SCALE: 1"=1'-0"

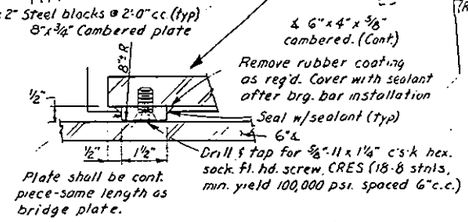




SECTION L-L
SCALE: 1-1/2"=1'-0"

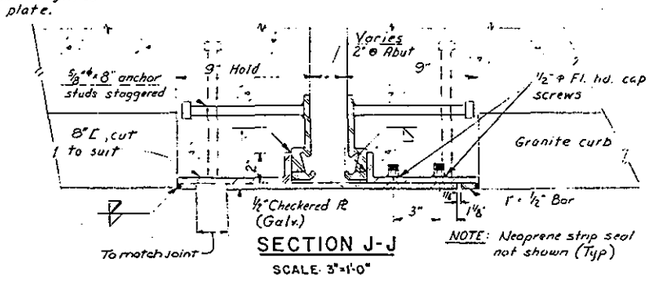
Note "A" - Angles to be set accurately to 6% slope & at correct cambered elevation. (Typ).
Note "B" - Concrete to be at same cambered slope as adjacent plates. Grind if necessary. (Typ).
Note "C" - Top cover plate not shown. Adjust height of 2" blocks at cover plate.
Note "D" - Apply two prime coats and initial screed coat only on this concrete surface.

ELEVATION (F/11)
SCALE 1"=1'-0"



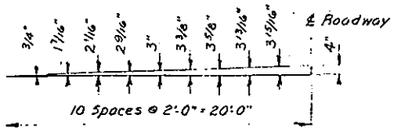
DETAIL (K/12)
SCALE: 3"=1'-0"

Remove rubber coating as req'd. Cover with sealant after brg. bar installation
Seal w/sealant (typ)
6" ℄

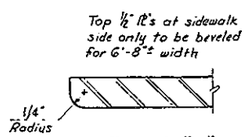


SECTION J-J
SCALE: 3"=1'-0"

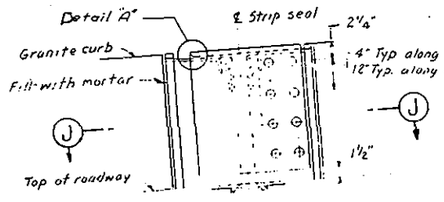
NOTE: Neoprene strip seal not shown (Typ)



ROADWAY CAMBER DIAGRAM
NO SCALE



DETAIL "A"
FULL SIZE



ELEVATION (H/11)
SCALE 1-1/2"=1'-0"

GRAPHIC SCALES
1" = 1'-0" 1' 0 1' 2'
1½" = 1'-0" 12" 6" 3" 0 6" 12"
3" = 1'-0" 3" 0 3" 6" 9"

VALUE ENGINEERING PAYS DIVIDENDS

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

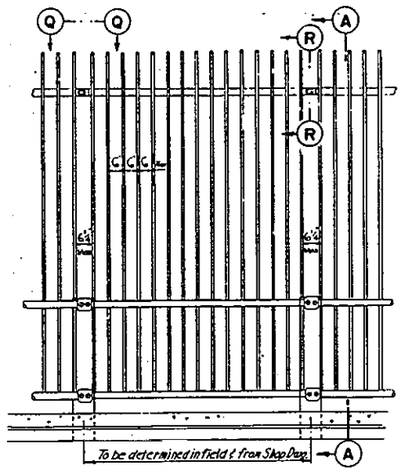
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES BY W.H.R.	DR BY R.D.P.	CK BY W.H.K.	
SUBMITTED Carlton R. Ingram CHIEF, STRUCT. SECTION			
APPROVAL RECOMMENDED Chief, Design Branch			
APPROVED Project Manager			
APPROVAL RECOMMENDED CHIEF, PROJECT BRANCH			

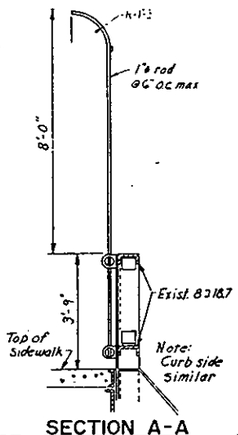
MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
EXPANSION DAM DETAILS III
BOURNE MASSACHUSETTS
APPROVED Joe B. Fryar CHIEF, ENGINEERING DIVISION DATE APRIL 1979
SCALE AS SHOWN | SPEC NO DACW33-79-B-0012
DRAWING NUMBER CAP-51

Figure 21

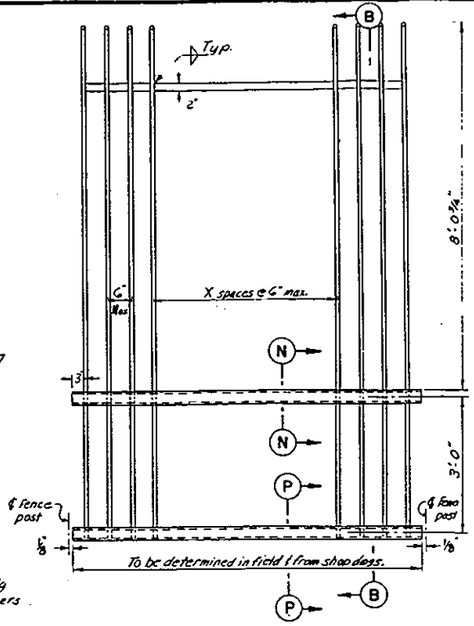
CORPS OF ENGINEERS — U. S. ARMY



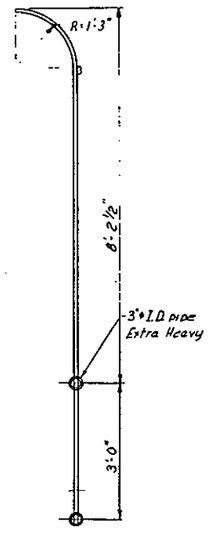
⚠SUICIDE DETERRING FENCE
SCALE: 1/2"=1'-0"



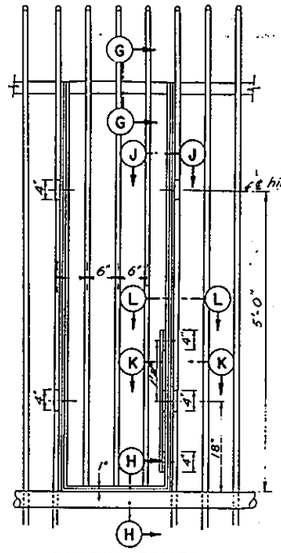
SECTION A-A
SCALE: 1/2"=1'-0"



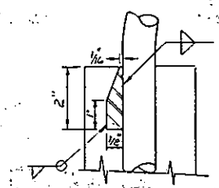
TYPICAL FENCE PANEL
SCALE: 3/4"=1'-0"



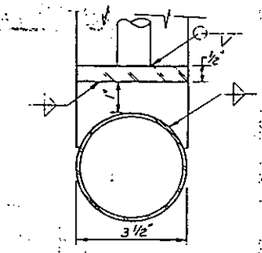
SECTION B-B
SCALE: 3/4"=1'-0"



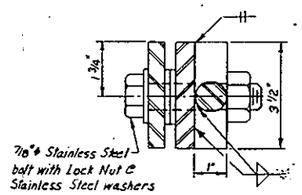
ACCESS PANEL
SCALE: 1"=1'-0"



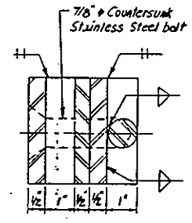
SECTION G-G
SCALE: 6"=1'-0"



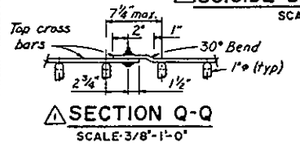
SECTION H-H
SCALE: 6"=1'-0"



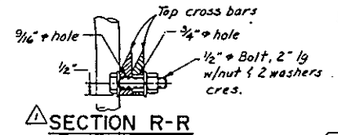
SECTION J-J
SCALE: 6"=1'-0"



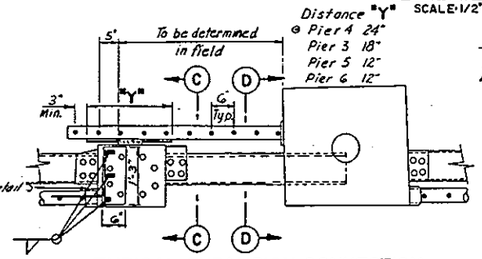
SECTION K-K
SCALE: 6"=1'-0"



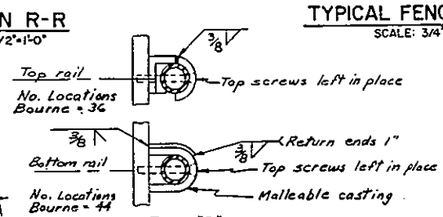
⚠SECTION Q-Q
SCALE: 3/8"=1'-0"



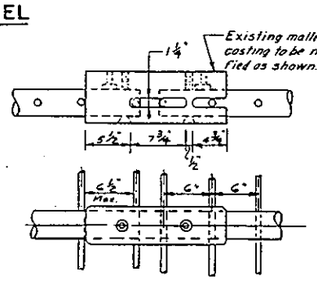
⚠SECTION R-R
SCALE: 1/2"=1'-0"



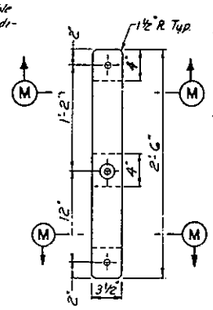
TYPICAL EXPANSION CONNECTION
SCALE: 3/4"=1'-0"



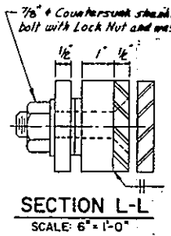
DETAIL "R"
NTS



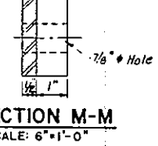
P-P 10 & 10'
EXPANSION CONNECTION
SCALE: 1 1/2"=1'-0"



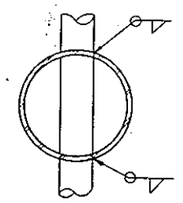
SUPPORT BAR
SCALE: 1 1/2"=1'-0"



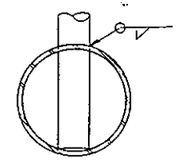
SECTION L-L
SCALE: 6"=1'-0"



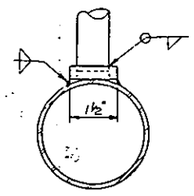
SECTION M-M
SCALE: 6"=1'-0"



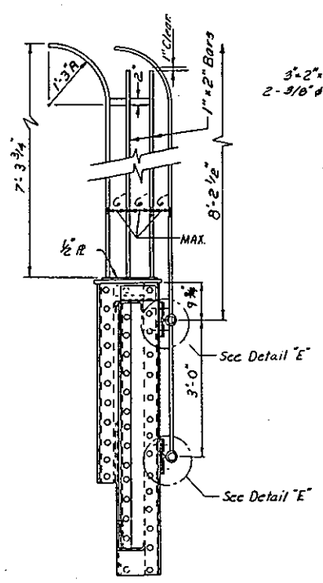
SECTION N-N
SCALE: 6"=1'-0"



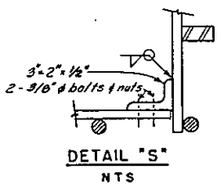
SECTION P-P
SCALE: 6"=1'-0"



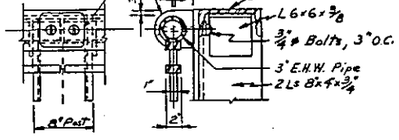
SECTION P-P
(ALTERNATE)
SCALE: 6"=1'-0"



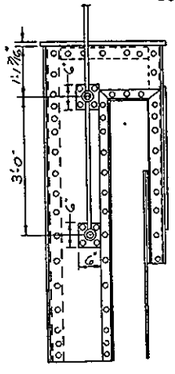
SECTION C-C
SCALE: 3/4"=1'-0"



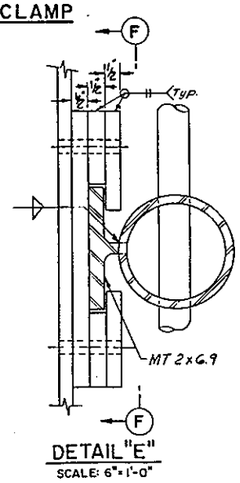
DETAIL "S"
NTS



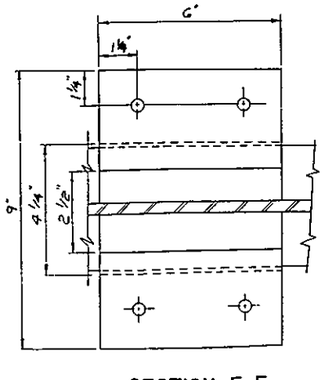
EXISTING RAILING CLAMP
SCALE: 1 1/2"=1'-0"



SECTION D-D
SCALE: 3/4"=1'-0"



DETAIL "E"
SCALE: 6"=1'-0"



SECTION F-F
SCALE: 6"=1'-0"

NOTES:
1. Fence Pickets are to be vertical.
2. Original shop drawings of existing railing showing geometric layout of panels are available at New England Division Headquarters.
3. Existing malleable castings shall be salvaged and used in installing new fence.
4. Access panels are to be centered in fence panels at 24 locations, as directed by Contracting Officer.
5. Details at lamp posts and abutments shall be designed in the field so as to maintain maximum spacing of 6 inches.

VALUE ENGINEERING PAYS DIVIDENDS

SAFETY PAYS

GRAPHIC SCALES
6"=1'-0"
1-1/2"=1'-0"
3/4"=1'-0"
1"=1'-0"
1/2"=1'-0"
⚠3/8"=1'-0"

REVISION	DATE	DESCRIPTION	BY
⚠1	MAY 79	ADDED SECTIONS Q-Q E R-R; REVISED DWG. (ANA #3)	CHIEF, ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
T.R.H.	W.E.ST.	T.R.H.

SUBMITTED: Chief, Struct. Section
APPROVAL RECOMMENDED: Chief, Design Branch
REVIEWED: Project Manager
APPROVAL RECOMMENDED: Chief, Project Branch

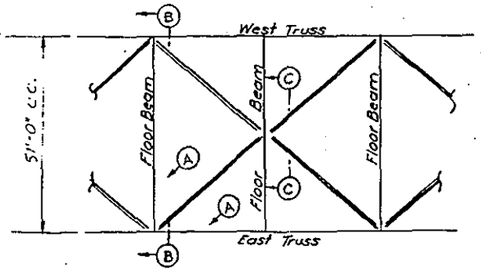
MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
NEW SUICIDE DETERRING FENCE- DETAILS
BOURNE — MASSACHUSETTS

APPROVED: Chief, Engineering Division — DATE: APRIL 1979

Figure 22

SCALE AS SHOWN | SPEC NO DACW33-79-B-0012
DRAWING NUMBER: CAP-51
SHEET 13

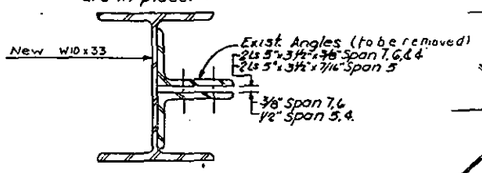
CORPS OF ENGINEERS — U. S. ARMY



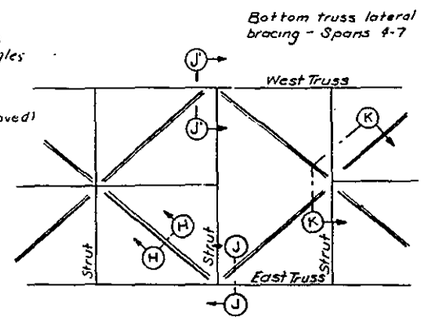
TYPICAL PLAN OF TOP LATERAL BRACING
SCALE 1/16"=1'-0"

DETAIL M1

NOTE: Provide new bracing angles for the Catwalk where existing catwalk bracing interferes with the installation of the new top lateral truss bracing. Remove the catwalk bracing angles after the new Catwalk Bracing Angles are in place.

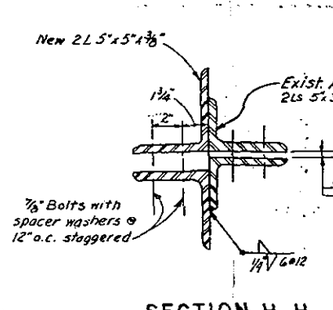


SECTION A-A
SCALE 3"=1'-0"

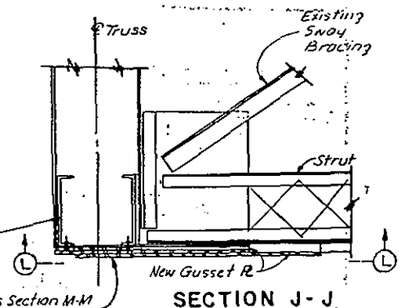


TYPICAL PLAN OF BOT. LATERAL BRACING
SCALE 1/16"=1'-0"

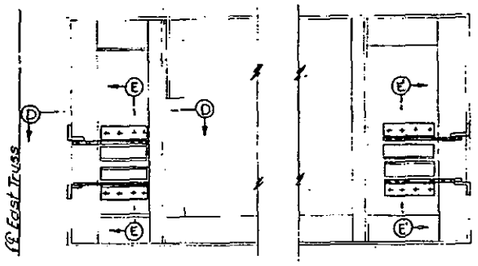
DETAIL M2



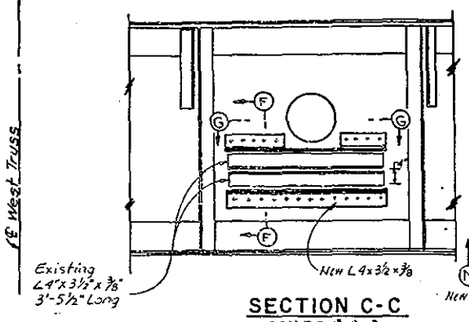
SECTION H-H
SCALE 3"=1'-0"



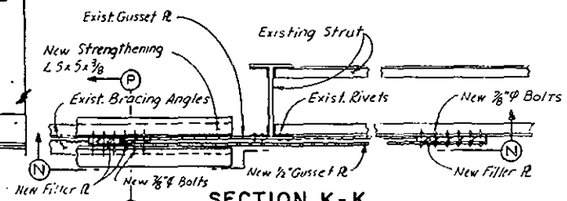
SECTION J-J
SECTION J'-J'
SCALE 3/4"=1'-0"



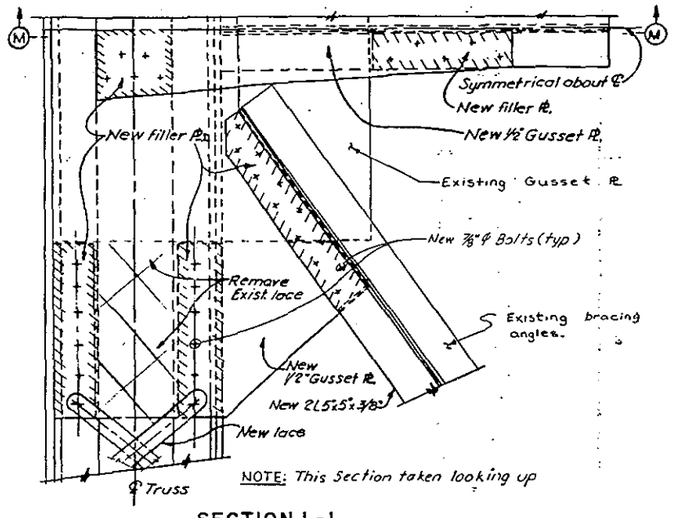
SECTION B-B
SCALE 3/4"=1'-0"



SECTION C-C
SCALE 3/4"=1'-0"

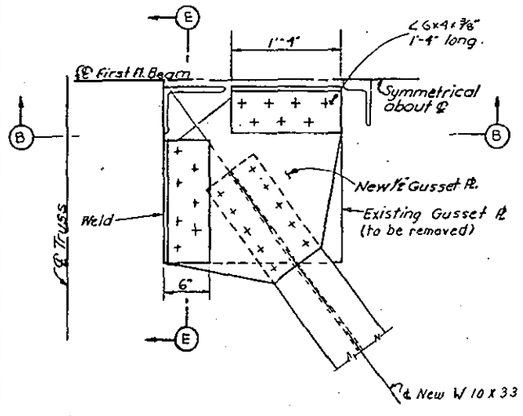


SECTION K-K
SCALE 3/4"=1'-0"

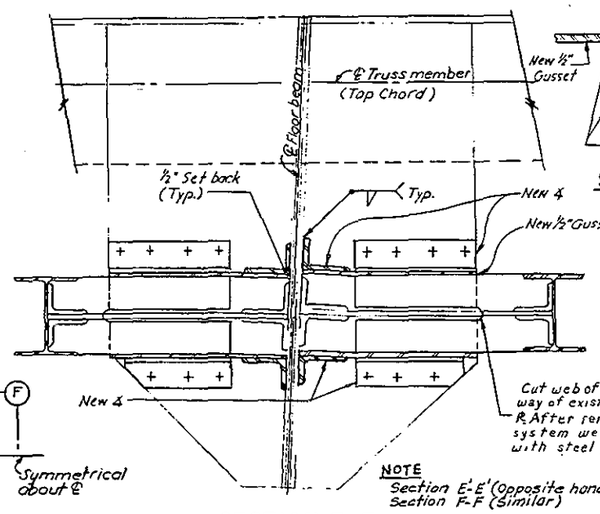


NOTE: This Section taken looking up

SECTION L-L
SCALE 1 1/2"=1'-0"



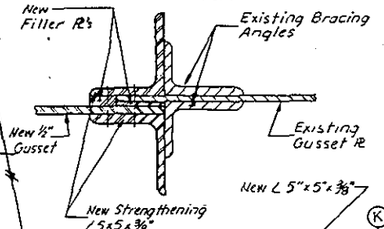
SECTION D-D
SCALE 1 1/2"=1'-0"



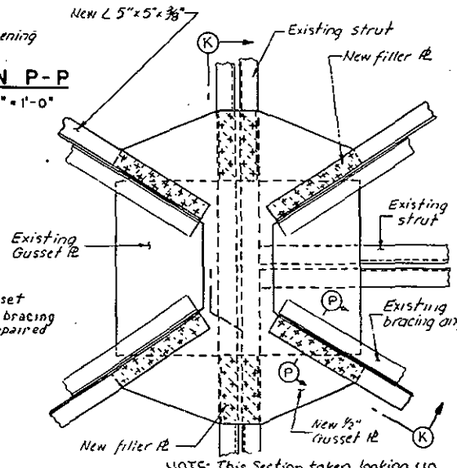
NOTE
Section E-E (opposite hand)
Section F-F (Similar)

SECTION E-E
SCALE 1 1/2"=1'-0"

NOTE: Remove existing top truss bracing after new bracing is installed. Do not leave holes in Floor beam web or truss members.

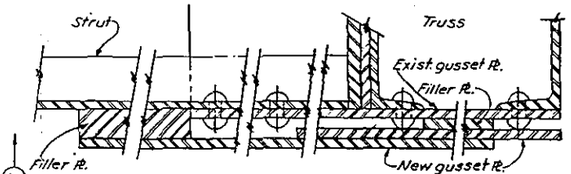


SECTION P-P
SCALE 3"=1'-0"

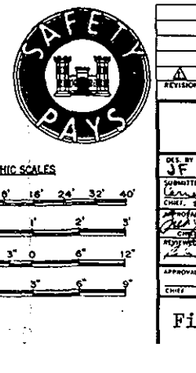


NOTE: This Section taken looking up.

SECTION N-N
SCALE 3/4"=1'-0"



SECTION M-M
SCALE 3"=1'-0"



GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY
1	11 MAY 79	REVISED SECTION H-H (AM" 3)	

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
JF	R.P	TKH

SUBMITTED: CHIEF, STRUCT. SECTION
RECOMMENDED: CHIEF, DESIGN BRANCH
RECOMMENDED: PROJECT MANAGER
APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

MAJOR REHABILITATION PROJECT
CAPE COD CANAL BRIDGES
BOURNE HIGHWAY BRIDGE
STEEL REPAIR DETAILS IV

BOURNE MASSACHUSETTS
APPROVED: DATE APRIL 1979
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO. DACW33-79-B-0012
DRAWING NUMBER: CAP-51

Figure 23